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**SIXTY-FIRST ANNUAL REPORT  
OF THE  
NORTH CAROLINA  
AGRICULTURAL EXPERIMENT  
STATION**

**I. O. SCHAUB, Acting Director**

**THE NORTH CAROLINA STATE COLLEGE OF  
AGRICULTURE AND ENGINEERING OF THE  
UNIVERSITY OF NORTH CAROLINA**

**AND**

**STATE DEPARTMENT OF AGRICULTURE  
COOPERATING**

**STATE COLLEGE STATION  
RALEIGH**



**FOR THE FISCAL YEAR ENDING JUNE 30, 1938  
PROGRESS REPORT FOR YEAR ENDING  
DECEMBER 1, 1938**



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# STATE INSTITUTIONS COOPERATING IN AGRICULTURAL RESEARCH



## STATE COLLEGE OF AGRICULTURE AND ENGINEERING OF THE UNIVERSITY OF NORTH CAROLINA

FRANK P. GRAHAM, *President.*

J. W. HARRELSON, *Dean of Administration.*

I. O. SCHAUB, *Dean of Agriculture.*

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## NORTH CAROLINA DEPARTMENT OF AGRICULTURE Raleigh, N. C.

W. KERR SCOTT, *Commissioner*

F. E. MILLER, *Director of Test Farms\**

\*The six test farms are owned and operated by the North Carolina Department of Agriculture, and the employees on these farms are members of the Department of Agriculture staff.

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# OFFICERS AND STAFF

of the

## NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

January 1, 1938

I. O. SCHAU	Acting Director
*F. E. MILLER	Director of Branch Stations
F. H. JETER	Agricultural Editor
A. F. BOWEN	Treasurer

### AGRICULTURAL ECONOMICS

G. W. FORSTER	Economist
R. E. L. GREENE	Assistant in Farm Management Research
M. TAYLOR MATTHEWS	Associate in Rural Sociology
ROBIN WILLIAMS	Assistant in Rural Sociology
†OLAF WAKEFIELD	Assistant in Rural Sociology
G. R. SMITH	Associate in Marketing Research
S. L. CLEMENT	Associate in Marketing Research
R. H. RAPER	Assistant in Cotton Marketing
MARC LEAGER	Associate Economist

### AGRONOMY

C. B. WILLIAMS	Agronomist
L. G. WILLIS	Soil Chemist
J. R. PILAND	Assistant Soil Chemist
J. F. LUTZ	Soil Investigations
W. H. RANKIN	Soil Fertility Investigations
E. R. COLLINS	Associate, Soil Fertility Investigations
W. W. WOODHOUSE	Soil Fertility Investigations, Cooperation with Tennessee Valley Authority
C. W. CROOM	Soil Survey, Cooperation with Tennessee Valley Authority
WM. GETTYS	Soil Survey, Cooperation with Tennessee Valley Authority
W. A. DAVIS	Associate in Soil Survey
E. F. GOLDSTON	Associate in Soil Survey
S. O. PERKINS	Soil Survey, in Cooperation with U. S. Department of Agriculture
ANTON J. VESSEL	Soil Survey, in Cooperation with U. S. Department of Agriculture
P. H. KIME	Associate in Plant Breeding
R. H. TILLEY, Statesville, N. C.	Assistant in Plant Breeding
J. H. MOORE	Cotton Technologist
D. B. ANDERSON	Cotton Fiber Investigations
R. L. LOVVORN	Associate Forage Crops Investigations
G. K. MIDDLETON	Associate Small Grain Breeding
W. H. CHAPMAN	Assistant Small Grain Breeding
F. O. BARTEL, Statesville, N. C.	In Charge, Soil Erosion Station

R. E. STITT, Statesville, N. C.	Assistant Agronomist, U. S. Department of Agriculture
†R. W. CUMMINGS	Associate Soil Chemist
ADOLPH MEHLICH	Associate Soil Chemist
P. H. HARVEY	Associate Agronomist
H. D. MORRIS	Assistant Agronomist
†N. E. RIGLER	Assistant Agronomist
THOS. KERR	Cotton Technologist, Cooperation Bureau of Plant Industry

#### ANIMAL INDUSTRY

R. H. RUFFNER	Head, Animal Industry
C. D. GRINNELLS	Dairy Investigations
J. L. MOORE	Assistant in Dairy Investigations
J. E. FOSTER	Associate in Animal Husbandry Investigations
E. H. HOSTETLER	Animal Husbandry Investigations
J. O. HALVERSON	Animal Nutrition
F. W. SHERWOOD	Associate in Animal Nutrition
F. H. SMITH	Assistant in Animal Nutrition

#### BOTANY

B. W. WELLS	Botanist
S. G. LEHMAN	Plant Pathologist
R. F. POOLE	Plant Pathologist

#### HORTICULTURE

M. E. GARDNER	Horticulturist
ROBERT SCHMIDT	Associate Horticulturist
C. F. WILLIAMS	Associate Horticulturist
IVAN D. JONES	Horticultural Biochemist
E. B. MORROW	Associate Horticulturist
OTTO VEERHOFF	Associate Horticulturist
M. K. VELDHIJS	Assistant Chemist, U. S. D. A. Food Research Division
J. L. ETHELLE	Assistant Bacteriologist, U. S. D. A. Food Research Division
C. E. VANDEMAN	Assistant Horticulturist

#### POULTRY

R. S. DEARSTYNE	Poultry Investigator and Pathologist
R. E. GREAVES	Assistant Poultry Investigator and Pathologist
H. C. GAUGER	Assistant Poultry Investigator and Pathologist
J. J. HUTCHINSON	Assistant Poultry Breeding
C. H. BOSTIAN	Poultry Genetics
REINARD HARKEMA	Parasitologist
F. W. COOK	Hematologist

#### ZOOLOGY AND ENTOMOLOGY

Z. P. METCALF	Entomologist
B. B. FULTON	Associate Entomologist

#### CENTRAL STATION

R. J. HARRIS	Assistant Director in Charge
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# BRANCH STATIONS\*

## *Blackland Test Farm, Wenona, N. C.*

J. L. REA, JR.	Assistant Director in Charge
A. P. LEFEVRES	Foreman
BRYAN HARRIS	Herdsman

## *Coastal Plain Test Farm, Willard, N. C.*

CHAS. DEARING	Assistant Director in Charge
D. P. SOUTHERLAND	Foreman
R. T. CALDWELL	Dairy Herdsman
C. O. BOLLINGER	Poultryman
W. H. STUART, JR.	Assistant Agronomist, U. S. Department of Agriculture

## *Mountain Test Farm, Swannanoa, N. C.*

S. C. CLAPP	Assistant Director in Charge
W. M. WHISENHUNT	Foreman
H. B. COULTER	Dairy Herdsman
H. B. SMITH	Poultryman

## *Piedmont Test Farm, Statesville, N. C.*

J. W. HENDRICKS	Assistant Director in Charge
R. E. STITT	Assistant Agronomist, U. S. Department of Agriculture

## *Tobacco Test Farm, Oxford, N. C.*

E. G. MOSS	Assistant Director in Charge
JAMES F. BULLOCK	Assistant Tobacco Investigations, U. S. Department of Agriculture
K. J. SHAW, Raleigh, N. C.	Assistant Tobacco Investigations, U. S. Department of Agriculture
T. E. SMITH	Assistant Tobacco Investigations, U. S. Department of Agriculture

## *Upper Coastal Plain Test Farm, Rocky Mount, N. C.*

R. E. CURRIN, JR.	Assistant Director in Charge
WM. ALLSBROOK	Herdsman
J. P. YOUNG	Assistant Tobacco Investigations, U. S. Department of Agriculture

† Resigned during the year.

\* Director resigned October 15, 1937.

\* The six test farms are owned and operated by the North Carolina Department of Agriculture, and the employees on these farms are members of the Department of Agriculture staff.



**SIXTY-FIRST ANNUAL REPORT**  
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**NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION**  
For the Year Ending  
**June 30, 1938**

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During the past year the Agricultural Experiment Station has continued to study measures for the control of factors affecting the economic and quality production of animals, poultry and plants. The Station has given attention to farm management and the matters that touch upon the human side of rural folk. It has not only conducted research on the many problems disturbing to agriculture, but has endeavored to give the results of research to the people of the state through radio, the newspapers, correspondence, and special publications.

The growers of peanuts, vegetables, truck, peaches, apples, bulbs, cattle and melons have requested additional help from the Station staff. Inquiries on various subjects indicate that the farmers of this state are sorely in need of research on many problems. The Station has attempted to meet these requests as best it can with the funds available and has followed a policy of assigning workers to new problems as soon as others are completed. This policy of definitely studying the problems requested by farmers has been followed for many years and all of the research projects have a very definite relation to the farmers' welfare.

The cooperation of the United States Department of Agriculture in the breeding of horticultural crops, pickle studies, animal industry research, and plant fertilization studies, and studies of cotton problems is acknowledged. The cooperation of the North Carolina Department of Agriculture in supporting the research work on the various test farms has been of much value to the Station staff.

Dr. R. Y. Winters, Director of the Station, resigned during the year. He had done much toward the breeding of cotton. Through his efforts the farmers of the state had become conscious of the value of an improved staple and quality of cotton and he had always maintained a zealous interest in the problems of the practical grower. He encouraged fundamental research but did not overlook practical objectives because he believed that a practical control of those problems hindering the success of every class of farmers was the first duty of the investigator.

### **HISTORICAL RECORD**

In order to complete the historical records regarding the transfer of the North Carolina Agricultural Experiment Station from the North Carolina Department of Agriculture to the North Carolina College of Agriculture and Mechanical Arts, now the North Carolina State College of Agriculture and Engineering, significant extracts are quoted here from the proceedings of a joint committee meeting of the Board of Agriculture and the Board of Trustees, Raleigh, December 5, 1889:

"That we, as a Committee, representing the Board of Agriculture and the Board of Trustees of the Agricultural and Mechanical College, recommend that the Board of Agriculture 'turn over' for the use of the Trustees of the A. and M. College, the following: N. C. Agricultural Experiment Station and its equipments."\*\*\*\*\*

"That the Board of Trustees of the A. and M. College 'receive' the above and all moneys receivable under the Land Scrip and Hatch Acts as a donation for their use as they are empowered to do under Section 6, Chapter 410, Laws of 1887, 'The said Board of Agriculture shall have power to accept on behalf of this state, donations of property, real or personal, and any appropriations which may be made by the Congress of the United States to the several states and territories for the benefit of Agricultural Experiment Stations'."\*\*\*\*\*

(Signed) A. LEAZER,  
J. F. PAYNE,  
R. W. WHARTON,  
*Committee Board of Agriculture.*

H. E. FRIES,  
*In behalf of the entire Committee  
of the Board of Trustees and upon  
instruction from Messrs. Carr and  
Alexander.*

"On motion of Dr. Smith, the report was received. Col. Green moved that the report be considered in Executive Session, by sections. The motion was adopted, and the Board went into Executive session.

"On motion of Mr. Leazer, the Board of Trustees took a recess for the purpose of allowing the Board of Agriculture to meet and pass upon the resolutions of transfer and to reassemble upon the call of the President.

"President Primrose, after the recess, called the Board of Trustees to order, and Mr. Fries presented the report of the Joint Committee on the transfer of the Experiment Station from the Board of Agriculture to the Board of Trustees of the A. and M. College.

"On motion the report, as a whole, was adopted."

## PUBLICATIONS

The following publications were issued by the Experiment Station or arose through cooperative work with the United States Department of Agriculture:

*The Organization, Practices, and Membership Participation of Two North Carolina Farm Cooperatives*, by S. L. Clement, Bulletin No. 311 (July, 1937).

*The Comparative Value of Peanut and Soybean Hay for Milk Production*, by C. D. Grinnells and J. L. Moore, Bulletin No. 312 (August, 1937).

*Relation of Fertilization and Selling Price to Profitableness in Cotton Production*, by C. B. Williams, Bulletin No. 313 (November, 1937).

*Effect of Superphosphate Upon the Yield and Earliness in Maturity of Cotton*, by C. B. Williams, T. S. Buie, S. V. Stacy, Bulletin No. 314 (November, 1937).

*Influence of Crop Rotation and Soil Treatment Upon the Yield of Crops on Porter's Loam Soils*, by C. B. Williams, W. H. Rankin, S. C. Clapp, Bulletin No. 315 (November, 1937).

- Adapting Standard and High Analysis Fertilizers to Truck Crop Soils*, by J. J. Skinner, R. A. Lineberry, H. B. Mann, E. R. Collins, Bulletin No. 316 (November, 1937).
- Cotton Marketing in the Salisbury Area of North Carolina*, by J. W. Wright, G. R. Smith, J. A. Shanklin, Bulletin No. 317 (December, 1937).
- Placement of Fertilizer for Cotton*, by E. R. Collins, H. B. Mann, G. A. Cummings, Bulletin No. 318 (April, 1938).
- Lettuce Growing in North Carolina*, by Robert Schmidt, Bulletin No. 319 (June, 1938).
- 59th Annual Report of North Carolina Agricultural Experiment Station.*

## TECHNICAL BULLETINS

- Bang's Disease in North Carolina*, by Wm. Moore, L. J. Faulhaber, C. D. Grinnells, Technical Bulletin No. 54 (November, 1937).
- Some Effects of Feeding Yeast Fermented Mash to Laying Pullets*, by R. S. Dearstyne, C. O. Bollinger, Technical Bulletin No. 55 (April, 1938).
- Comparison of Protein Supplements for Fattening Pigs*, by J. E. Foster, Earl H. Hostetler, Technical Bulletin No. 56 (May, 1938).
- Menhaden Fish Oil as a Source of Vitamin D for Growing Chicks*, by J. O. Halverson, F. H. Smith, F. W. Sherwood, R. S. Dearstyne, Technical Bulletin No. 57 (June, 1938).

## TECHNICAL ARTICLES

- A Critical Evaluation of the Rat-Growth Method for Determining Vitamin B and Its Contents in Meals from Certain Oily Seeds*, by F. W. Sherwood and J. O. Halverson, *Journal of Agricultural Research* 56, 1938 (June 15).
- Extraction of Gossypol with Different Ethers; Causes of Varying Results*, by J. O. Halverson and F. H. Smith, *Industrial and Engineering Chemistry, Anal. Ed.*, 9, 516, 1937.
- Revised Method for the Estimation of Gossypol in Cottonseed Meal*, by F. H. Smith, *Ind. and Eng. Chem., Anal. Ed.*, 9, 517, 1937.
- A Response of Alfalfa to Borax*, by L. G. Willis and J. R. Piland, *Am. Soc. Agron.*, Vol. 30, Jan., 1938.
- Some Recent Observations on the Use of Minor Elements in North Carolina Agriculture*, by L. G. Willis and J. R. Piland, *Soil. Science*, Vol. 44, Oct., 1937.
- The Influence of Constant Light and Temperature Upon the Structure of the Walls of Cotton Fibers and Collenchymatous Cells*, by Donald B. Anderson and J. H. Moore. *Amer. Jour. Botany*, Vol. 24, Oct., 1937. (In cooperation with U. S. Department of Agriculture.)
- Inheritance in a Cross Between *Avena sativa* and *Avena sterilis ludoviciana* (thesis)*, by G. K. Middleton. *Am. Soc. Agron.*, Vol. 30, March, 1938.
- Adapting High Analysis and Concentrated Fertilizers to Cotton Soils*, by J. J. Skinner, H. B. Mann, E. R. Collins, E. T. Batten and R. P. Bledsoe. *Soil Science*, Vol. 44, July, 1937.
- Effect of Some Nitrogenous and Other Constituents of the Cotton Plant as Separated by Electrodialysis at Different Stages of Growth*, by E. R. Collins and Neil E. Rígler. *Soil Science*, Vol. 22, Sept., 1937.
- Fertilizer Placement and Fertilizer Particle Size:*
- (1) *Results of Mechanical Application of Acid and Neutral Fertilizers, and Fertilizers of Different Particle Sizes to Cotton in North Carolina in 1937.*
  - (2) *Fertilizer Placement Studies with Corn in North Carolina.*
  - (3) *Fertilizer Placement Studies in North Carolina with Peanuts.*
- by E. R. Collins, *Proc. 13th An. Meeting of the National Joint Committee on Fertilizer Application*, Nov. 19, 1937.

- Potash Requirements of Cotton in Relation to Acid and Neutral Fertilizers*, by E. R. Collins, R. P. Bledsoe, J. J. Skinner and J. H. Hunter. 39th Proc. Assoc. Sou. Agr. Workers, Feb., 1938, p. 63.
- Ruffle-Leaf, a New Disease of Tobacco in North Carolina*, by S. G. Lehman, Plant Disease Reporter 21: 296-297, 1937.
- Ruffle-Leaf of Tobacco* (Abstract), by S. G. Lehman, Phytopathology, January, 1937.
- Results of Seed Treatment Tests with Cotton in 1937*, by S. G. Lehman, (Abstract), Phytopathology, 28: 664-665, 1938.
- Seed Infestation with Glomerella gossypii in the 1936 Cotton Crop*, by S. G. Lehman, Plant Disease Reporter 21: 4-6, 1938.
- Notes on the Megachilid subgenera Xeromegachile and Derotropis. (Hymenoptera, Megachilidae)*, by T. B. Mitchell, Pan-Pacific Entomologist XIV: 168-177; figs. 1-4, October, 1938.
- The Fulgorina of Barro Colorado and other parts of Panama*, by Z. P. Metcalf, Bulletin of the Museum of Comparative Zoology at Harvard College 82: 277-424; pls. 1-23, October, 1938.
- Farm Tenancy in North Carolina 1880-1935*, by Robin M. Williams and Olaf Wakefield, AE-RS Information Series No. 1, September, 1937.
- An Economic Study of Peach Farms in the Sandhill Area of North Carolina*, by G. W. Forster and R. E. L. Green, AE-RS Information Series No. 2, November, 1937.
- Recent Changes in Tax Rates on Farm Real Estate in North Carolina*, by G. W. Forster, AE-RS Information Series No. 3, November, 1937.
- Rural Youth Studies in the United States*, by Robin M. Williams, AE-RS Information Series No. 4, July, 1938.
- The Farm Organization and Management*, by G. W. Forster, Prentice-Hall, N. Y., October, 1938. (Book.)

#### AGRONOMY INFORMATION CIRCULARS

- Fertilizers for Different Crops Including the Best Percentage of Water-Insoluble Nitrogen of Totals in Fertilizer Mixtures*, by Staff, (April, 1937—not reported in previous report), No. 107.
- Tobacco Fertilizer Recommendations for 1938*, by Tobacco Committee (August, 1937), No. 108.
- Sources of Fertilizer Materials*, by J. F. Lutz (January, 1938), No. 109.
- Results of Cotton Variety Experiments, 1933-37*, by P. H. Kime (February, 1938), No. 110.

## SOIL STUDIES

**Soil Survey of Counties of the State.**—North Carolina was one of the first states in the South to begin soil survey work with the United States Department of Agriculture, it having begun work in 1900. Since that time this phase of work has been steadily carried on without interruption and now more than four-fifths of the area of the state has been surveyed.

All the survey work conducted during the current year has been done on a scale of 2.64 inches to the mile, except that done in Warren county which was mapped on a scale of one inch to the mile. The work has been conducted in cooperation with the Federal Bureau of Chemistry and Soils and the Tennessee Valley Authority, except in Warren county where the cooperative agency was the Federal Bureau of Chemistry and Soils alone.

During the year Warren, Swain and Transylvania counties have been completed and 69.6 percent of Jackson and 35.2 percent of Mitchell has been worked. At the present time this work is confined to counties wholly or partially within the T.V.A. area of the state.

By means of this work the soils are identified and classified into separate types based upon their physical and chemical characteristics, such as natural features or stoniness, slope, geographical position and drainage, together with the extent of erosion, degree of plant food exhaustion, present productive capacity, potentialities and other characteristics. The reports prepared by the field men in the field before they leave the areas of the different counties are edited and published by the United States Department of Agriculture. These reports with the accompanying maps are of very great service to agricultural workers and farmers. The use of them is so great that it is almost impossible to keep a supply of the reports on hand in the office of the Department to meet the demands. (C. B. Williams, W. A. Davis, E. F. Goldston, William Gettys, C. W. Croom, C. E. Kellogg, W. E. Hearn, J. W. Moon, S. O. Perkins and A. J. Vessell.)

**Soil Deficiencies.**—A new perspective in research on soil chemistry problems has been introduced by evidence of a widespread occurrence of boron deficiency in the state. This becomes acute in most instances only when lime is applied, but on the other hand the boron problem becomes a dominant factor in all liming experiments.

During the progress of the experimental work it has been found necessary to proceed on the basis of certain assumptions or theories the accuracy of which may not be definitely established. Objective tests of these theories in the field have yielded evidence that borax will in some degree control the symptoms heretofore considered characteristic of manganese and magnesium deficiency. Work now in progress is designed to test the further assumption that the boron problem is relative to the concentration or to a hypothetical activity of calcium in the soil and that this balance modifies in significant degree the functional effects of plant nutrients.

Until more information has been obtained on this subject the project on magnesium deficiency will be merged with the boron studies.

Efforts have been continued to identify significant oxidation-reduction potentials in soils. The direct measurement of potentials has not given satisfactory results but several indirect or tell-tale methods have shown promise.

Some confusion has arisen regarding the nature of objective tests conducted in the field. Fundamentally they constitute true or false tests of theories derived principally from technical investigations. They are frequently conducted on extremely unproductive soils where the variability is such that no satisfactory quantitative data is obtainable. In many cases the results have been very strikingly beneficial and farmers have profited directly from the work. This activity is different in principle from the standard field experiment and demonstration although it may be equally effective or profitable in its application to practical problems. (L. G. Willis)

**Relative dependability of chemical analyses and field plat experiments in formulating fertilizer recommendations for crops.**—The main objectives of the problem is to identify factors which influence crop yield. Fertilizers influence crop growth by supplying nutrients and correcting soil defects. The study is designed to differentiate between the direct and indirect functions that fertilizing materials may have upon plant growth.

Chemical tests of 1000 miscellaneous soil samples representing some 9000 individual tests support the idea that fertilizers have direct functions, viz: that of supplying needed plant nutrients, as well as indirect functions which may or may not produce a favorable soil environment for plant growth. The efficiency of fertilizing materials and limes may be increased by the application of various chemical salts to the soil which supply either calcium, magnesia, sulfur, manganese, copper, or boron.

The majority of soils examined seem to be low in available nutrient elements when measured by chemical tests. Liming to reduce soluble aluminum and manganese and to supply available calcium and magnesia particularly on acid sandy soils seems of very great importance.

Several soils have been selected and brought to the greenhouse for detailed study.

The problem is largely one of promoting a more precise use of fertilizing and liming materials. (J. R. Piland and L. G. Willis)

**A laboratory investigation of certain inherent soil properties which affect the erosiveness and fertility of soils.**—Previous work has shown that highly aggregated soils are less erosive than those which are not appreciably aggregated. The same publication contained data showing that soils which absorbed large quantities of hydration water (water of swelling) were more erosive than those which swelled less. The aggregation and hydration were affected by the kind of ions absorbed on the colloidal complex. Later investigations showed a positive correlation between the amount of iron present in the soil and aggregation. This is very important in view of the fact that our southern soils contain high accumulations of iron.

In order to investigate in more detail the effects of iron on several physicochemical properties of soil, iron bentonite suspensions were used. These were prepared by adding ferric chloride to electrodyalyzed bentonite suspensions and washing until no more chlorides were washed out. Iron was added in different concentrations up to 250 percent of the absorption capacity.

The amount of iron and chloride washed out was determined and subtracted from the amount added, the difference being taken as the amount



adsorbed. Fe adsorption increased according to the Freundlich adsorption isotherm. Chloride adsorption followed the Fe adsorption in a linear relationship up to about 75 percent saturation with iron; then increased rapidly to 100 percent iron saturation; and, then repeated almost the same procedure between 100 and 200 percent iron saturation.

The chloride adsorption may be regarded as indicative of the anion exchange capacity and, since it increases with iron adsorption, it would be expected that southern soils would have the capacity to adsorb large quantities of phosphates, sulphates, nitrates, etc. From a soil fertility viewpoint this is very significant, especially since large quantities of nitrates and phosphates are used on southern soils.

Viscosity determinations show that small additions of iron (12.5%) cause a big increase in viscosity followed by a rapid decrease up to 100 percent iron saturation. The increase is due to occluded water, therefore flocculation, because swelling determinations show a decrease in hydration water over the same range of iron concentration. The decrease from 12.5 percent to 75 percent iron saturation is caused by further dehydration. This is borne out by the swelling determinations.

Previous investigations have shown that the swelling of bentonite was increased by adding Li, Na, K, Ca, or Ba to the H-colloid. The data now at hand, as discussed above, show that iron causes a decrease. This, together with the fact that aggregation of southern soils is positively correlated with the free iron content strongly indicates that iron is of paramount importance in causing the granular, dehydrated condition of lateritic soils. Thus, it is of considerable importance from both a soil fertility and a soil conservative viewpoint. (J. F. Lutz)

**Studies of the factors affecting the aggregation of soil and its effect on run-off and erosion.**—Several physico-chemical properties of soils from the Soil Erosion Experiment Station at Statesville, and from the fertility plats of the Branch Station also at Statesville, were investigated to determine their effect on runoff and erosion and on crop yields. The soils from both stations belong to the Cecil series.

The Erosion Station data showed that good aggregation of the soils was beneficial in reducing runoff and erosion. Aggregation was affected by the fertilizers and crops as follows:

- (1) The condition of the organic matter is probably as important as the amount in influencing aggregation. The Cecil soil is better aggregated when the humate and phosphate complexes are combined with the sesquioxides than when they are combined with calcium and magnesium.

- (2) Liming decreased aggregation of the top soil in all except one plat. This exception is explained as being a residual effect of the original acid humus.

- (3) Continuous cultivation of cotton resulted in a significant decrease in aggregation.

- (4) A four-year rotation which included lespedeza gave better aggregation than a continuous sod of shallow-rooted grasses. There was less run-off and erosion on the continuous grass plat due to the mechanical effect of the grass in holding the water and soil rather than to the condition of the soil. Cultivation of the grass plat would undoubtedly result in greater runoff and erosion than from the four-year rotation.

As stated above, liming decreased aggregation (except on one plat) and in every case where there was a reduction in aggregation of the top soil there was a reduction in the average yields of cotton, corn and wheat. (Averages of four-year rotation of cotton, corn, wheat, red clover since 1918.)

Liming also reduced the exchangeable potassium in both the topsoil and sub-soil which, with the decreased aggregation, resulted in lower yields of cotton, corn and wheat. (J. F. Lutz and Jesse Elson)

**Relation of chemical and soil factors to parasitic diseases of plants (Agronomy Department in cooperation with the Department of Plant Pathology).**—Diseases caused by many different parasitic fungi and bacteria cause crop losses amounting to millions of dollars annually. Observations have shown that the occurrence and severity of some diseases are dependent upon soil conditions and on climatic factors. Investigations dealing with conditions affecting wilt diseases of plants caused by *Bacterium solanacearum* were started in 1937. From observations relative to the normal distribution of the disease, it appeared that it may be associated with an unfavorable oxidation-reduction equilibrium. Since this in turn may indicate that infection is dependent upon a primary injury to the plant through a defective environment, reducing conditions were created by flooding Norfolk sandy loam (previously inoculated with *B. Solanacearum*) in the greenhouse, and through the addition of filter paper. With tomatoes, tobacco, and sunflower as test plants, only in the case of the sunflower did flooding definitely favor disease (wilt development).

Treatment of the soil with chemicals, notably sulphur, iron and aluminum oxides, indicated no definite success in controlling wilt.

Observations in the field in the Coastal Plain (based on two or more soil types in the same field) showed Granville wilt of tobacco often more severe on Portsmouth than on Dunbar, and least on Norfolk. Wilt appeared to be limited to Okenee sandy loam and to depressional areas on Kalmia sandy loam, but it appeared to be entirely absent on Kalmia sand. In the Piedmont Plateau wilt seemed to be prevalent on all soils developed from triassic sandstones and shales, including Granville, White Store, Creedmore and Mayodan. In fields where wilt was just being introduced, it usually appeared first in locations where drainage water tends to accumulate.

Soil samples were collected from fields where disease (mainly Granville wilt) occurred. These are being analyzed, chemically and physically, and through observation in the field during the growing season correlations established between soil factors and plant disease. The investigations are supplemented by pot experiments in which plant nutrient ratios are varied, conditions of reaction varied, the effect of organic constituents and partial sterilization studied. (Preliminary results indicate that chloropicrin effectively controlled *B. solanacearum*). Observations dealing with changes in the nature of the soil microflora and their antagonistic effect on disease organisms are contemplated.

Attention is being given to the improvement and adoption of chemical and biological methods for the effective and specific measurement of soil properties which relate to these problems. For the determination of the base exchange capacity, base and hydrogen saturation, and lime require-



ments of soil a new method has been developed using a triethanolamine acetate-barium hydroxide buffer. This extractant is buffered at pH 8.2 and is consequently superior to neutral salt solutions which have been used heretofore. Effective replacement of the hydrogen-ion is accomplished through the introduction of hydroxyl ions, and effective replacement of the metal cations is accomplished through the active barium ion. The formation of insoluble carbonates, phosphates, and humates of barium is prevented in the presence of triethanolamine acetate buffered at pH 8.2. The above stated chemical properties of soil can be determined therefore, with greater accuracy and efficiency. (Adolf Mehlich)

**A study of farm organization and soil management practices in Franklin and Wilson counties, North Carolina (in cooperation with the Department of Agricultural Economics).—**Farm business and farm practice records were taken on 172 farms in Franklin county, and on 136 farms in Wilson county in 1936 for the crop year 1935. Farm maps were available for most of the farms. In addition to cultural features, they showed (1) degree of erosion, (2) slope, (3) land use, and (4) soil type. The farm practice schedule provided for data on the following soil management practices: (1) terracing, (2) other engineering practices, (3) pasture establishment, (4) reforestation, (5) cover crops, (6) rotations, (7) strip-cropping, (8) contour tillage, (9) fertilizers and lime use, and (10) relationship of crops to erosion, slope, soil type, etc.

The data have been summarized and reported, with partial analysis. Some of the results of a further analysis are given here.

The following table shows the percent of the corn, cotton and tobacco which was fertilized, the average rate and analysis of the fertilizer, and the amount of top dressing used expressed as pounds of nitrogen per acre.

TABLE 1

County	Crop	Total Acres	Per Cent Fertilized	Rate Per Acre	Formula			Lbs. N. Top Dressing Per Acre
					N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	
Franklin.....	Corn.....	1,114	63.82	178	2.73	7.74	3.01	14.93
	Cotton.....	582.4	90.52	317	3.04	8.1	3.93	23.7
	Tobacco.....	419.8	100.	902	3.12	8.20	4.23	20.2
Wilson.....	Corn.....	1,241.25	70.07	204	2.9	7.74	3.09	18.8
	Cotton.....	487.9	100.	458	3.06	8.16	3.38	13.4
	Tobacco.....	858	100	1,059	2.78	7.98	3.41	7.57

The following table shows the effect of previous crops on the yield of cotton, corn and tobacco. The low yield of tobacco following corn and the high yield of corn following tobacco clearly illustrates the extent to which a crop is affected by the fertilizer applied the preceding year (see Table 2).

TABLE 2

	Franklin County	Wilson County
Tobacco gave highest yield following.....	Cotton	Idle land
Tobacco gave lowest yield following.....	Corn	Corn
Cotton gave highest yield following.....	Other crops*	Other crops*
Cotton gave lowest yield following.....	Idle land	Corn
Corn gave highest yield following.....	Tobacco	Tobacco
Corn gave lowest yield following.....	Idle land	Idle land

\*Other crops included wheat, oats, cowpeas, corn and cowpeas, spring wheat and cowpeas, and watermelon in the Franklin county area, and melons, peas, oats, beans, peanuts, sweet potatoes and soybeans in the Wilson county area.

Table 3 shows the yields per acre and the rate and kind of fertilizers used by tenants, part owners, and owners.

TABLE 3

Crop	Type Owners	Yield Per Acre		Fertilizer Used			
		Franklin	Wilson	Franklin		Wilson	
				Rate	Kind	Rate	Kind
Corn..... (bushels)	Tenants.....	15.33	26.32	70	2.94-8.06-2.95	168	2.57-6.94-4.28*
	Part Owners...	19.02	26.82	107	2.35-8.44-3.33	169	2.79-7.91-2.81
	Full owners...	19.24	23.73	134	2.79-7.69-3.0	146	2.92-7.87-2.84
Cotton..... (lbs.)	Tenants.....	259	306	336	3.06-8.26-3.22	398	3.29-8.57-3.86
	Part owners...	248	357	292	2.97-7.70-3.19	509	2.89-8.11-3.20
	Full owners...	265	302	274	3.01-8.08-3.10	448	3.06-8.10-3.35
Tobacco.....	Tenants.....	896	1,027	838	3.06-8.11-4.14	1,133	2.87-8.13-3.35
	Part owners...	972	1,170	840	3.14-8.05-4.36	1,046	2.12-8.15-3.68
	Full owners...	944	1,122	897	3.02-8.17-4.18	1,070	2.78-8.16-3.33

\*Percentage is higher because of a heavy application of kainit on Farm No. 97 Where Farm No. 97 is omitted the average is 2.77.

The kind of soil used for tobacco was tabulated and the distribution in Franklin county was: Appling, 82.1 percent; Cecil, 6.1 percent; and Durham, 11.8 percent. This is approximately in line with the total area of these soil series.

In Wilson county 76 percent of the tobacco was on Norfolk with others as follows: Dunbar 11.2 percent; Ruston, 5.5 percent, Cuthbert, 4.5 percent, and all others, 2.8 percent.

The data were investigated to determine if the idle land was followed mainly by tobacco and it was found that in both counties it was not. (C. B. Williams, J. F. Lutz and R. E. L. Greene)

### QUICK TESTING AND APPRAISAL OF SOILS FOR FARMERS

During the year about 5400 samples of soil brought in or sent in to the Agronomy Department by farmers of the state have been examined and appraised. The value of this work to them is attested by the increasing numbers of samples which come to the department from year to year without any publicity except that of word of mouth on the part of those who have benefited by the service. Up to the present the examination and appraisal of the soil samples has consisted in the main in establishing the soil types, their physical condition, the character of drainage, their topography, their approximate content of organic matter, and their pH readings. The information resulting from the examinations, coupled with the results at hand from carefully conducted field experiments enables the department to give reasonably accurate recommendations in each case with reference to what should be done in the way of fertilizer, lime and other treatments of the soil for producers to obtain best paying results from the crops grown on the soils. The examinations, with the interpretations, have shown that many North Carolina soils are suffering from acute plant-food deficiencies and for too high or too low pH values which have to be corrected by intelligent treatments before normal and profitable crop yields can be secured. (C. B. Williams and W. H. Rankin)

### FERTILIZER STUDIES

**Studies on phosphate fertilization in cooperation with T.V.A.**—The object in this work is to determine the best form of phosphate for the principal mountain soils, three Piedmont soils, and one Coastal Plain soil, using ammoniated monocalcium phosphate, ammoniated superphosphate, monocalcium phosphate, dicalcium phosphate, tricalcium phosphate, and 16 percent superphosphate with three sources of nitrogen.

The basis used in making measurement is yield of treatment 14 (superphosphate, muriate of potash, cottonseed meal  $\frac{1}{4}$  N, nitrate of soda  $\frac{1}{4}$  N, sulfate of ammonia  $\frac{1}{2}$  N). In series A no filler is used, while in series B, 500 pounds of ground dolomitic limestone is used per ton of fertilizer mixture.

**With grasses for hay (average of four fields for four years):**

**Series A**—Ammoniated monocalcium phosphate increased the yield over the base of 12 percent. Ammoniated superphosphate gave an increase of 10 percent. Monocalcium and tricalcium phosphates gave an increase of about 4 percent and dicalcium phosphate was equal to the base.

**Series B**—Ammoniated monocalcium phosphate increased the yield 9 percent and tricalcium phosphate 7 percent above the base, while ammoniated superphosphate, monocalcium phosphates were about equal to the base.

**With corn (in mountains, average of nine fields for two years):**

**Series A**—Monocalcium phosphate gave an increase of about 10 percent, ammoniated monocalcium phosphate, dicalcium phosphate and tricalcium phosphate about 6 percent and ammoniated superphosphates was about equal to the base.

**Series B**—All phosphates used were very near the base yield.

**With corn (Piedmont and Coastal Plain, average of five fields for two years):**

**Series A**—Monocalcium phosphate gave an increase over the base of 7 percent, dicalcium phosphate 6 percent, and ammoniated monocalcium phosphate, ammoniated superphosphate and tricalcium phosphate were about equal to the base.

**Series B**—Monocalcium and dicalcium phosphates gave an increase of about 12 percent. Ammoniated superphosphate and tricalcium phosphate gave increases of about 6 percent with ammoniated monocalcium phosphate about 3 percent.

**With wheat (in mountains, average of two years, 9 fields first year, 7 fields second year):**

**Series A**—Ammoniated superphosphate, dicalcium phosphate, monocalcium phosphate and tricalcium phosphate gave increases above the base of 7, 6, 5 and 3 percent, respectively. Ammoniated monocalcium phosphate was about equal to the base.

**Series B**—Monocalcium phosphate gave an increase of 6 percent. All other phosphates were about equal to the base.

**With cotton, (Piedmont and Coastal Plain, average of five fields for two years):**

**Series A**—Ammoniated superphosphate was equal to the base, ammoniated monocalcium phosphate 6 percent below, monocalcium and dicalcium phosphate 9 percent below the base, and tricalcium phosphate 15 percent below the base.

**Series B**—Ammoniated superphosphate was equal to the base. Ammoniated monocalcium phosphate and monocalcium phosphate were 3 percent below the base, and dicalcium phosphate 4 percent below the base. Tricalcium phosphate was 11 percent below the base.

**With pasture (average of one field for four years in Mountains, dry weight basis):**

**Series A**—Monocalcium phosphate produced an increase of 2 percent above the base, and ammoniated superphosphate 4 percent below. Dicalcium phosphate was 9 percent below, ammoniated monocalcium phosphate 12 percent below, and tricalcium phosphate 13 percent below.

**Series B**—Ammoniated monocalcium phosphate was 2 percent above the base and ammoniated superphosphate and monocalcium phosphate were equal to the base. Dicalcium phosphate was 5 percent below, and tricalcium phosphate 27 percent below.

**General Conclusions**—There is no apparent difference in the efficiency of the several phosphates studied when used with nitrate of soda, sulfate of ammonia or a mixture of the two as sources of nitrogen, except in two instances with corn in the Piedmont and Coastal Plain in which nitrate of

soda was considerably more efficient, especially when more concentrated forms of phosphate was used.

With the exception of hay grasses in the mountains and of cotton in the Piedmont and Coastal Plain, monocalcium phosphate appears, under the conditions covered by experiments, to be the most efficient source of phosphate.

With hay grasses ammoniated monocalcium phosphate appeared to be slightly more efficient.

With cotton, ammoniated superphosphate and the base treatment were the most efficient.

No consistent increase has been produced by the use of ground limestone as a filler in the fertilizer mixture. (W. W. Woodhouse)

**Studies on Fertilizer Fillers.**—The object in this experiment is to determine the relative efficiency of triple superphosphate and 16 percent superphosphate as sources of phosphoric acid when used in a complete fertilizer with various fillers, viz: dolomitic limestone, calcium silicate slag and gypsum.

**Some Findings from Results:** The average yield of three plots, using a 4-10-4 fertilizer with no filler and phosphate from 16 percent superphosphate is used as the base yield.

Using the base yield as 100 percent, the table following shows the relative yield of the different phosphates and fillers used in this experiment.

1. With Corn (Piedmont, average of one field for one year):

Source of Phosphate	Source of Filler	Percent Yield Based on Yield of Base as 100 Percent
Triple superphosphate.....	Granular calcium silicate slag.....	109
16% superphosphate.....	Dolomitic limestone.....	106
Triple superphosphate.....	Dolomitic limestone.....	103
16% superphosphate.....	None (base).....	100
16% superphosphate.....	Gypsum.....	99
Triple superphosphate.....	None.....	99
None.....	Dolomitic limestone.....	97
Triple superphosphate.....	Ground calcium silicate slag.....	94
None.....	None.....	94

2. With Corn (Coastal Plain, 1 field for 1 year):

Triple superphosphate.....	Gypsum.....	118
16% superphosphate.....	Dolomitic limestone.....	114
Triple superphosphate.....	None.....	108
Triple superphosphate.....	Dolomitic.....	108
None.....	None.....	108
16% superphosphate.....	None (base).....	100
Triple superphosphate.....	Granular calcium silicate slag.....	98
Triple superphosphate.....	Ground calcium silicate slag.....	98
None.....	Dolomitic limestone.....	90

## 3. With Corn (Mountains, average of 2 fields for 2 years):

Source of Phosphate	Source of Filler	Percent Yield Based on Yield of Base as 100 Percent
None.....	Dolomitic limestone.....	108
None.....	None.....	100
16% superphosphate.....	None (base).....	100
Triple superphosphate.....	Gypsum.....	92
Triple superphosphate.....	Granular calcium silicate slag.....	91
16% superphosphate.....	Dolomitic limestone.....	88
Triple superphosphate.....	Ground calcium silicate slag.....	82
Triple superphosphate.....	Dolomitic limestone.....	78
Triple superphosphate.....	None.....	72

## 4. With Cotton (Piedmont and Coastal Plain, average of 2 fields for 2 years):

Triple superphosphate.....	Gypsum.....	102
16% superphosphate.....	Dolomitic limestone.....	102
16% superphosphate.....	None (base).....	100
Triple superphosphate.....	Dolomitic limestone.....	93
Triple superphosphate.....	Granular calcium silicate slag.....	92
Triple superphosphate.....	None.....	89
None.....	None.....	85
Triple superphosphate.....	Ground calcium silicate slag.....	84
None.....	Dolomitic limestone.....	82

## 5. With Wheat (Mountains, average of 2 fields for two years):

Triple superphosphate.....	Granular calcium silicate slag.....	118
Triple superphosphate.....	Ground calcium silicate slag.....	108
16% superphosphate.....	Dolomitic limestone.....	107
16% superphosphate.....	None (base).....	100
Triple superphosphate.....	Gypsum.....	97
Triple superphosphate.....	Dolomitic limestone.....	95
Triple superphosphate.....	None.....	89
None.....	None.....	78
None.....	Dolomitic limestone.....	76

**General Conclusions.**—No difference in the efficiency of triple superphosphate when used with different sources of nitrogen were found except in the Coastal Plain where nitrate of soda was consistently better than sulfate of ammonia or a mixture of the two.

Triple superphosphate with gypsum as a filler produced the best yields on the Coastal Plain soil.

Granular calcium silicate slag consistently produced higher yields than the ground calcium silicate slag when used as a filler in the fertilizer mixture, which suggests that in the ground form more soluble materials may have been supplied than are beneficial.

The use of a filler in the fertilizer mixture with triple superphosphate seems to be beneficial on all soils studied.

Materials, other than dolomitic limestone, seem to work well as fillers. Granular calcium silicate slag and gypsum seem to be the best of those studied.



In all cases, triple superphosphate with some form of filler has produced as high or higher yields than 16 percent superphosphate as the source of phosphoric acid. (W. W. Woodhouse)

**Studies of Fused Rock Phosphate fertilization of corn and cotton.**—The object in these experiments is to compare the relative efficiency of fused phosphate rock and 16 percent superphosphate in a complete fertilizer in the production of corn and cotton grown on one Piedmont and one Coastal Plain soil. The following results have been secured:

**1. With corn (Piedmont and Coastal Plain, 2 fields for 1 year):**

The results of one year's crop indicate that there is little difference between these two phosphates.

**2. With cotton (Piedmont and Coastal Plain, 2 fields for 1 year):**

One year's results fail to give any significant difference between the two. (W. W. Woodhouse)

**Calcium Metaphosphate and Triple Superphosphate studies on<sup>\*</sup> soil types in the Mountains.**—The object in these experiments is to compare calcium metaphosphate, triple superphosphate and 16 percent superphosphate as sources of phosphoric acid in complete and incomplete fertilizer mixtures when used on mountain soil types in two rotations. The rotations include one of corn, wheat and lespedeza on upland soil, and the other of continuous corn and crimson clover on bottom land soil. The findings in these experiments are as follows:

**1. With corn (upland, 1 field, 2 replications for 1 year):** Calcium metaphosphate in a 4-10-4 mixture plus dolomitic limestone produced the highest yield, but as all yields in this field the first year were very close no significant differences were apparent.

**2. With wheat (upland, 1 field, 2 replications for 1 year):** The average yield of all 4-10-4 mixtures was 28 percent above the average of the 4-0-4 mixtures. Calcium metaphosphate in a 4-10-4 mixture without filler gave an increase over the 4-0-4 of 45 percent, while triple phosphate in a 4-10-4 mixture gave an increase of 28 percent. The average of all 0-10-0 plats gave an increase above the 4-0-4 of 7 percent.

**3. With corn (bottom land, 1 field, 3 replications for 1 year):** The average of all 4-10-4 treatments gave only a slight increase over the 4-0-4. Calcium metaphosphate in a 4-10-4 mixture plus lime gave a 9 percent increase. The average of all 0-10-0 treatments gave a decrease below the 4-0-4 of 11 percent. Rather low response from phosphate was obtained on corn the first year, while an excellent response was obtained on wheat. (W. W. Woodhouse)

**Influence of acid and neutral fertilizers of different composition on quality and yield of cotton, Irish potatoes and sweet potatoes, and on soil fertility conservation of different soil types.**—

**A. Cotton:**

Comparisons were made between acid and neutral fertilizers containing varying amounts of potash.

Cotton plant analyses indicated that increasing the potash content of an acid fertilizer decreased the calcium oxide content of the plant, while in the case of the neutral fertilizers the calcium content of the plant was slightly increased as the potash content of the fertilizer was increased. The magnesium content of the plants were higher where the fertilizer was neutralized with dolomitic limestone than where an acid fertilizer was used. The increase in the potash content of the plant was in proportion to the amount of potash in the acid fertilizer but the increased potash content in the plant did not result in increased yields at the higher amounts. (E. R. Collins, N. E. Rigler and J. J. Skinner)

**Studies of the efficiency of rock phosphate and superphosphate as sources of phosphoric acid.**—Each year's record adds further substantiating evidence to that already collected in showing that when the same amount of phosphoric acid is used from the two sources, superphosphate is more efficient, as measured by increased yields. (C. B. Williams and W. H. Rankin)

**A study of the yield and quality of succeeding crops when wheat and corn are grown continuously and when grown in two and three-year rotations with and without legumes.**—The results show that longer rotations, that is three-year rotations, are superior to shorter ones. (C. B. Williams and W. H. Rankin)

**Fertilizer and lime requirements for crops in three-year rotations of corn; oats and vetch, soybeans turned under; rye turned under, soybeans for seed.**—The yields of soybean seed in 1937 follow closely data collected in previous years on Dunbar fine sandy loam, except most all treatments produced yields much above their normals. The soybeans have produced larger yields on the plats that have received lime in addition to complete fertilizer. This experiment in its present form was discontinued with the crop of 1937. (C. B. Williams and W. H. Rankin)

**Fertilizer and lime requirements of crops grown on Dunbar fine sandy loam in a three-year rotation of corn; oats and vetch and soybeans turned under, soybeans for seed.**—The two findings that are important in this experiment are, viz: first, complete fertilizer is necessary for all of the crops in this rotation on this soil; and second, that basic slag as the source of phosphoric acid gave crop yields that have been good without the development of symptoms of manganese deficiency. This experiment was discontinued in its present form with the crop of 1937. (C. B. Williams and W. H. Rankin)

## TOBACCO STUDIES

**Tobacco recommendations for 1938.**—Two members of the Agronomy staff, as in previous years, have participated in the formulation of the tobacco recommendations for 1938, which are for the states of Virginia, North Carolina, South Carolina and Georgia. The committee is constituted of agronomists from all these states and two representatives from the United States Department of Agriculture. As during the previous year, the recommendations have included those for the proper fertilization of tobacco and economic remedies for combatting the more common diseases and insect pests of this crop.



The fertilizer part of the recommendations has been issued as an Agronomy Information Circular of this Department, and is sent out to county agents, vocational teachers of agriculture, and others interested upon request. Thousands of requests for these have come in to the Department annually from farmers, and fertilizer manufacturers and mixers; for the farmer as supplying specifications for the fertilizers he had best use; and for the latter in giving definite directions for the fabrication of fertilizers they are to manufacture and offer for sale in the state and elsewhere where bright tobacco is grown in the South. It will be found from year to year that the consumption of those mixtures recommended by the tobacco committee are decidedly on the increase. This attests the recognized practical value of the recommendations for those who are growing bright tobacco in the state and elsewhere. (C. B. Williams, et al)

**Further studies on the effect of soil treatment for the control of black shank of tobacco caused by *Phytophthora Nicotinae*.**—Following heavy rains during the early season, black shank became severe over a wide area of Forsyth county. It appeared in many plant beds and in new fields for the first time, indicating its importance and the advisability of growers practicing sanitary measures. In 1937 the disease was discovered in an area of Pitt county at least 250 miles from the original source of soil infection in this state. (Fig. 4). Studies of the disease in Pitt county where more than five acres of tobacco died have not accounted for the source of infection.



Fig. 4.—Tobacco test planting in Pitt County showing severe Black shank the second year after the soil became infected.

Residual control effects of sulfur on the control of the disease was much less pronounced than in the 1937 season. The plants did not die as rapidly on soil treated with sulfur in 1935 and also 1936, but less than 10 percent of the plants grew to maturity on soil that had been treated with 300, 400 and 800 pounds of sulfur.

Treatment of infected Cecil soil, on which a heavy crop of cowpeas were grown and turned under with sulfur at the rates of 400, 600, 800 and

1000 pounds of sulfur to the acre on March 31, failed to control the disease. These results tend to show that seasonal conditions play an important part in the control effectiveness of any chemical applied to the soil for the control of fungi, since definite evidence of control values were seen in experiments on the same soil in 1936 and 1937.

The soil reaction was reduced to pH 4.0, but the stability of the reaction was variable. The heavy rainfall and buffer reactions apparently accounted for the short period at which the soils remain at the high pH where sulfur was applied. (R. F. Poole)

**Further studies on the effects of soil treatment for the control of Granville wilt caused by *Bacterium Solonacearum*.**—The planting season was two weeks earlier than in 1937, and tobacco was transplanted during the early and favorable season, resulting in advanced maturity. The Granville wilt, which reaches severeness under high soil temperatures, occurred on about the same date as in other years, and therefore did not appear to be as serious as in other years. These effects were reflected in the results of wilt control as compared with results obtained in 1936 and 1938, because a larger number of plants reached maturity under 1938 conditions.

Plants on the alkaline plats with a reaction of pH 7.42 died earlier than on check plats. Those on acid plats died later than on check plats, due to the unfavorable soil reaction of pH 4.0. After five years of study of the behavior of tobacco on the two reactions, there was no natural evidence that continuous maintenance of either extreme reaction for tobacco growing is favorable for the control of the parasites and organisms antagonistic to it.

Following erratic but often favorable results of control obtained by applying sulfur and hydrated lime to the soil in previous years, additional applications of sulfur and lime were made in February, 1937, and worked into the soil. In this study 800, 1000 and 1500 pounds of sulfur to the acre were applied. The results showed a low of 26.6 percent of the plants at the end of the harvest period where 800 pounds each of sulfur and lime were applied. For the 1000 and 1500 pound applications the losses were 11.3 percent, and none, respectively. The tobacco on plats that received 800 and 1000 pounds of sulfur was of good quality, but it was severely stunted on plats that received 1500 pounds.

Since the tobacco grown on soils treated with the combined sulfur and lime mixture had grown poorly in the past, indicating especially deficiency of nitrogen, tests were undertaken to overcome this deficiency with different forms of nitrogen. On infected Granville soil near Creedmoor, and Norfolk soil near Fort Barnwell, cotton seed meal and nitrate of soda gave good response. The cottonseed meal applied at the rates of 500 and 1000 pounds to the acre in April produced good quality tobacco on soil that had been treated with 800 and 1000 pounds each of sulfur and lime in February. There was also less kill of plants where the cottonseed meal was applied. An additional application of 1000 pounds of lime in the row also had similar effects. These results tend to show that soil treatment with sulfur for the control of wilt will be difficult to apply practically, although some field tests appear at this time to be promising. (Fig. 5).

The plat that received copper sulfate applications at the rates of 500 and 1000 pounds to the acre in 1935, continue to show a suppression of

growth of grasses and weeds, but allowed slightly greater growth of tobacco than in the previous years. However, the loss of plants due to Granville wilt amounted to 69.9 and 21.6 percent, respectively, where the chemical was applied at the rates of 500 and 1000 pounds to the acre.

The Granville wilt disease is rapidly establishing itself throughout the eastern part of the state. There is some evidence that dissemination in some cases is due to the downy mildew situation, which has forced growers to obtain plants from many sources with the result that infected soil was moved to lands that heretofore were not infected. Studies of the spread-



Fig. 5.—Control of tobacco with 1000 pounds each of sulfur and hydrated lime and partial recovery of growth conditions where cotton seed meal was broadcast in the row.

ing activities in the coastal flat lands indicate that the organisms may remain in isolated areas for several years before general infestation takes place. (R. F. Poole)

**Marketing of Flue-cured tobacco in North Carolina.**—This project, begun in 1936, is designed to study the methods and practices employed in marketing flue-cured tobacco and to determine the factors affecting the price of this important crop. The Farmville market area in Pitt and Greene counties was selected for the study this year. With the aid of the county agents, warehousemen of Farmville, and others, approximately 200 crops on 100 farms were selected as a sample. As tobacco was sold a record was obtained of each sale, showing the date of sale, pounds sold, price paid, name of the buyer and the buyer's and federal grade of each lot. While some difficulties were encountered in obtaining complete records, information was obtained on slightly more than one million pounds, or approximately 5 percent of the total producer's sales on the market. In addition to the sales record, the growers were interviewed for the purpose of obtaining information on production, curing, grading, and marketing practices.

Tabulation of the price data has been practically completed but little analysis of it has been made. (S. L. Clement)

**Parasites of the Tobacco Hornworm.**—The life history studies of the most important hornworm parasite, *Apanteles congregatus*, Say, and the hyperparasite, *Hypopteromalus tabacum* Fitch have been nearly completed. Incomplete life history studies have also been made on two unidentified Dipterous parasites of the hornworm. (B. B. Fulton)

**Tobacco Mosaic.**—The work of this project has been confined to continuation of the tests set up for the purpose of learning how long the virus of common tobacco mosaic retains its virulence in contact with soil stored under different temperature and moisture conditions. While only tentative conclusions can be drawn at this time, it appears that the virus is inactivated more rapidly in soil on the acid than on the alkaline side of pH 7. Soil temperature appears to have a marked effect on rapidity of inactivation of the virus in soil, high soil temperatures favoring rapid inactivation and low soil temperatures slowing down the process. Inactivation occurred more rapidly in soil to which certain organic materials were added to promote microbial activity than in the same soil to which such materials were not added. (S. G. Lehman)

## COTTON STUDIES

**Cotton Seedling diseases and seed treatment.**—The work of this project has centered on the treatment of cotton seed. By means of greenhouse and field tests an attempt has been made to evaluate certain preparations containing copper, zinc, sulfur, mercury, or other elements having fungicidal properties as seed treatment materials for cotton. Another part of the work has been to determine the value of the best of these preparations as nearly as possible in relation to particular seed borne parasites. Two of the tests were planned and put in as a cooperative undertaking in the regional seed treatment tests sponsored by the Seedling Disease Committee of the Cotton Disease Council. Other of the tests were non-cooperative, that is, not part of the regional test program.

In the local phase of the regional tests at the Upper Coastal Plain Branch Station, involving a comparison of acid delinted, mechanically delinted, and fuzzy seed each untreated and treated with Cuprocide, Ceresan, New Improved Ceresan, and Barbak C, the mechanically delinted seed was, as indicated by seedling emergence and survival, superior to fuzzy and acid delinted seed in a planting made April 20, and equal to fuzzy seed but statistically superior to the acid delinted seed in a later planting made May 4. The rank of the chemical treatments in descending order of effectiveness was (1) New Improved Ceresan, (2) Ceresan, (3) Cuprocide, (4) Barbak C, and (5) Control (untreated) at both dates of planting. Each chemical preparation gave a statistically highly significant increase of surviving seedlings.

The increase due to New Improved Ceresan was significantly greater than its nearest competitor in the planting made May 4.

In another test in which two other mercury containing preparations, Sanoseed and Sterocide, were compared with Ceresan, each preparation produced highly significant increases in surviving seedlings but the increase due to Ceresan was more than twice as great as that produced by the other preparations. This test was located on Norfolk sandy loam soil



and ample moisture was available for germination at both dates of planting. In another test made on Cecil sandy loam in a locality where moisture conditions following planting were such that approximately half the hills came up promptly and others tardily but with a fairly uniform distribution of this condition over the entire test. Ceresan increased the stand 45.8% and Sanoseed 39.8%, the difference being less than that required for statistical significance. A preparation of copper sulphate and another of cupric carbonate gave increases approximately equaling those of Sano-seed and not differing from Ceresan by significant amounts. Six other preparations containing copper, manganese, boron, or sulphur produced increases but the highest of these was less than half that produced by Ceresan.

Three lots of seed of Mexican 128-6 all grown on the same farm but in different years, 1934, 1936 and 1937 were tested to determine the effect of Ceresan treatment on seed of different ages. These lots differed not only in respect to age but also in amount and kind of pathogenic fungi carried as indicated by laboratory and greenhouse tests. A large proportion of the 1937 seed carried *Glomerella gossypii* and *Fusarium* sp., while these fungi were present and viable in considerably lower proportion of the 1936 seed and in none of the 1934 seed. On the other hand, many of the 1934 seed apparently because of low vitality were attacked on the laboratory germinator and prevented from germinating by *Aspergillus* while this fungus attacked comparatively few of the 1936 and 1937 seed. In the field tests the increases in stand of surviving seedlings resulting from use of Ceresan were equally as large for the 1934, *Glomerella*-free, low vitality, seed as for the 1937 seed infested with *Glomerella* and *Fusarium*. The lowest percentage increase was on the 1936 seed, which was relatively low in *Glomerella* infestation compared to 1937 seed, and relatively low in susceptibility to injury from *Aspergillus* compared to 1934 seed. It appears that seed treatment of the kind here used gives some protection to low vitality seed enabling many of them to germinate which would otherwise be prevented from doing so by such fungi as *Aspergillus* and *Rhizopus*, not usually regarded as aggressive seedling parasites.

When seed infested with pathogenic fungi are planted many seedlings are killed before emergence. Others become infected after emergence and develop more or less extensive lesions commonly designated "sore shin". An attempt was made to determine the general effect of seed treatment with Ceresan in reduction of this disease on emerged seedlings. Counts of diseased and healthy seedlings were made on treated and untreated rows planted to seed one and two planting seasons from harvest. Fewer seedlings developed sore shin on two year than one one year old seed. Also a great reduction in sore shin was apparent on treated seed as compared to untreated seed. The average weight per emerged seedling was significantly higher for two than for one year old seed, and also significantly higher for treated than for untreated seed.

The seeds used in this test were known to be highly infested with *Bacterium malvacearum*, a common leaf and boll parasite on the cotton plant. A study was made of the effect of Ceresan treatment on seedling infection by this organism. Treatment of seed with Ceresan reduced greatly the amount of this disease on cotyledons but did not eliminate it.

A small proportion of the treated seedlings developed cotyledonary lesions. Under the conditions of highly humid and rainy weather which followed and the close proximity of adjacent untreated rows this difference was not maintained so that treated and untreated rows showed about equal numbers of diseased secondary leaves three weeks later.

Some attention was given to determining the fungi present on diseased cotton seedlings. The fungi most frequently found were *Glomerella gossypii*, *Fusarium moniliforme*, *Fusarium* sp., *Pythium*, and *Rhizoctonia*. On seedlings from untreated seed not more than 1 year old *Glomerella gossypii*, *Fusarium moniliforme* and *Fusarium* sp. were most frequently found. *Pythium* and *Rhizoctonia* and *Fusarium* sp. were the prevailing forms on seedlings grown from treated seed or from seed more than 1 year old.

A study is being made of *Fusarium moniliforme* as a seedling and boll parasite. The results of this study will appear later in a master's thesis manuscript. (S. G. Lehman)

### INVESTIGATIONS IN MARKETING

**Cotton Grade and Staple Production in relation to consumption and local market price.** Nature and cost of cotton movement in North Carolina.—This study, started in 1928 and carried on continuously since its origin, is designed to furnish data on the quality of cotton produced in North Carolina. For the year 1937-38, 44 ginners cooperated and sent 49,720 samples of cotton to Atlanta for classification. The results of individual bale classifications are sent to the cooperating ginners and to over half of their patrons. The United States Department of Agriculture uses these data in weekly and monthly reports giving the grade and staple of the current crop. The North Carolina Agricultural Experiment Station uses the grade and staple data in connection with price studies, quality of ginning studies, and as a basis for advising the Extension Division in their quality improvement program. A manuscript on the grade and staple of North Carolina cotton has been prepared. (G. R. Smith and R. H. Raper)

**The relation of local cotton marketing facilities to community cotton improvement and standardization.**—This study has been completed and the findings published in Station Bulletin No. 317. (G. R. Smith)

**Cotton marketing practices in the Coastal Plain area of North Carolina.**—The purposes of this study are to determine the marketing practices of farmers, the structure of the local market, the buying and selling practices of local buyers, and the movement of cotton for the Coastal Plain area of the state. Four counties were selected for study. Approximately 80 farmers and practically all the local buyers, cotton warehousemen, public weighers, and about one-half of the ginners were interviewed in each area and data for the 1935-36 season were recorded on questionnaires prepared for this purpose. The results of this study will be published during 1938-39. (G. R. Smith)

**A study of fertilizer placement factors in influencing the stand, growth and quality of cotton.**—The largest yields were obtained by bedding the land ten days before planting and placing the fertilizer in two bands six

inches apart in a separate operation from planting, immediately preceding planting with a walking planter. (E. R. Collins, J. J. Skinner and G. H. Cummings)

**Fiber and plant qualities of cotton varieties representing types grown in the cotton states and the effect of seasonal, soil and climatic conditions on these qualities.**—The object of this experiment is to make a study of fiber and plant characters of upland varieties of cotton representing various types in order to secure data on their relative value for manufacturing purposes, disease resistance, adaptability, yield and other desirable characters, and the influence of soil, seasonal and climatic conditions on these characters.

The regional variety test has been carried on at Statesville for three years. This is one of 14 similar experiments conducted throughout the cotton belt. One or more of these tests are located in each of the main cotton growing states from North Carolina to Texas. The same 16 varieties were grown in all tests and a 3-year supply of seed was purchased at the beginning of this experiment. These varieties represent various types grown in different parts of the cotton belt. They show a wide range in earliness, plant type and growth and from  $\frac{3}{4}$  to  $1\frac{1}{4}$  inches in staple length. Detailed records have been secured on plant, boll, fruiting, and other characters. Small samples of seed cotton are saved for fiber studies and 50-pound samples for spinning tests. When the field data was completed it was forwarded to the Division of Cotton and Other Fiber Crops and Diseases, Washington, D. C., where it will be analyzed statistically along with results secured on other tests. In this way the reaction of variety characteristics to different soil, climatic and seasonal conditions may be studied. The relation of various fiber characters to spinning quality are also being studied. Fiber studies and spinning tests are now being made by the Federal Bureau of Agricultural Economics. (P. H. Kime and R. H. Tilley)

**Cotton breeding with special reference to the inheritance and value of fiber qualities recently identified with superior spinning quality.**—In this experiment breeding for better quality, higher productivity and disease resistance, special attention was given to the relation of fiber characters to spinning quality.

The breeding program includes line selection work with the Mexican variety for improvement in fiber and plant characters, studies of fiber and plant characters of standard varieties and some hybridization work.

Twelve strains selected from Mexican 128-6 were in the advanced strain test at the Central and Piedmont Experiment Stations during the 1937 season. Data was secured on length of lint, lint percentage, yield, earliness, and size of boll, and studies will be made on diameter of fibers, fiber weight per inch and lint index. Plant characters of these strains are very much alike, slight differences were observed in length, uniformity and fineness of fiber, and yield. A large number of plant-to-row progenies and several increase blocks were grown.

Thirty-seven lines selected from Mexican 87-8 and 26-3 were studied at the Upper Coastal Plain Station, Rocky Mount. Some of them were very promising from the standpoint of fiber characters, earliness, boll size and yield.

Data on length and uniformity of fiber, boll size, earliness, yield and plant characters were secured on several commercial varieties grown at three locations in the state. It is planned to make further studies on fiber characters of these varieties.

Hybridization work was begun in 1936. Nine commercial varieties having staple lengths of 1-1/32 to 1-1/8 inches, and possessing other desirable characters such as large bolls, high yields, and earliness were used as parental material. A total of 16 combinations were secured. The  $F_1$  of these crosses were grown in 1937 and about 500 double crosses were made from this material, as many different combinations as possible being secured. Seed stocks of several varieties and strains have been inbred for two years and are available for foundation seed stocks. (P. H. Kime and R. H. Tilley)

**Fusarium wilt of cotton, with respect to the possible existence of different biological forms, and the effect of potash on the control of wilt.**—This experiment is designed to study the relative susceptibility of varieties when grown in different localities, and the effect of the use of varying amounts of potash in the form of muriate on their susceptibility.

This experiment is located in Richmond county on the farm of George Smith, of Rockingham. The soil type is Norfolk sand. It has been heavily infested with *Fusarium* wilt for several years. The twelve varieties in the experiment represented several types and ranged from very susceptible to highly resistant. Varying amounts of potash were applied to each variety as follows: 800 pounds per acre of 6-8-0, 6-8-4 and 6-8-8. Counts were made of the wilt infected plants at intervals throughout the growing season. Sea Island No. 13B3 was the only variety showing no infection. Varieties considered highly resistant ranged from 13 to 35 percent infection. Two susceptible varieties had infection of 76 and 78 percent. Highly resistant varieties showed considerable wilt where no potash was added. Four percent of potash in the fertilizer reduced infection considerably and 8 percent still more. Four percent potash increased yields considerably over no potash, and 8 percent further increased the yields of susceptible varieties, but was of little if any benefit to resistant varieties.

Yields were low due to boll weevil damage early in the season and extremely dry weather during mid-summer. The soil was heavily infested with nematodes.

Results from this experiment will be compared with results from other wilt infested areas to determine whether the various varieties react differently when grown on other areas, which might indicate more than one biological form of *Fusarium* wilt. (P. H. Kime and O. P. Owens)

**Stand and field uniformity as affecting cotton yields.**—This experiment has been put out to determine the minimum length of skip which will cause a reduction in yield and the relationship of skips of varying lengths to the reduction in yield and from the data secured to formulate correction factors for adjusting yields of plats on which skips of varying lengths occur.

Skips of from 2 up to 10 feet made in the middle row of 3-row plats at thinning time. The plats were 25 feet long and the cotton was spaced in 12 inch hills in the rows. A perfect stand check was also included.



Plats were randomized and replicated 10 times. Three pickings were made, yields were recorded on each 25-foot row. Boll counts were made on each plant and the number tabulated on a chart showing the relative position of each plant in the row. The field data was forwarded to the Division of Cotton and Other Fiber Crops, Washington, D. C., for statistical analysis. This work has not been completed but the averages show a close correlation between length of skip and reduction in yield, especially in skips of 4 to 10 feet. (P. H. Kime and R. H. Tilley)

**Relation of fiber properties to spinning quality.**—The main object of this project, which was begun in 1932, is to study the physical properties of fibers from improved varieties and to note the relation of contrasting properties to spinning value. The results show significant differences in the staple length, fiber diameter, fiber weight, strength per fiber, percent of thin-walled fibers, and yarn strength when the varieties are compared. The data also indicate that the influence of the growing season is an important factor which influences certain fiber properties and yarn strength. A report summarizing the results is being prepared for early publication in Technical Bulletin No. 58. (In cooperation with the Federal Bureau of Plant Industry). (J. H. Moore)

**Relation of the distribution of fiber population on the cotton seed to fiber length, strength, diameter, weight and wall development.**—This work was started in 1935. Dated material from several improved varieties has been saved, and work is now being carried on to develop suitable methods of measuring the density of the fiber population at selected points on the seed coat and the relation of this degree of density to the various fiber properties mentioned above. (J. H. Moore)

**Origin and early stages of elongation in the cotton fiber.**—The main object of this project, which was begun in 1934, is to study the origin of cotton fibers on the seed and to note any division of cells in the epidermal layer of the ovule subsequent to fertilization. Daily stages of the fruit, ranging from flower buds to mature bolls, have been preserved in several fixatives. Examination of the material has shown definitely that numerous cell divisions occur in the epidermal layer after the date of flowering, but the observations indicate that the lint hairs originate during the first few days after the appearance of the flower. Work is now under way to determine whether any of these cell divisions in the epidermal layer lead to the formation of cotton fibers. (J. H. Moore)

## CORN STUDIES

**Study of yields and quality of succeeding crops when cotton, corn, small grain and peanuts are grown continuously and when they are combined in two, three and four year rotations.**—The plats have received the same rotation since 1924 and the same fertilization since 1927.

Some of these plats, particularly the four-year rotation plats are showing deficiency symptoms resulting in complete loss of the leaves from the cotton plants. These results show that normal fertilization as applied to a farm practice or a continuous crop is not satisfactory in a rotation. This may account for the fact that corn yields have been increased by the rotation to a much greater extent than have those of cotton.

This experiment has been discontinued. (E. R. Collins and C. B. Williams)

**Fertilizer and lime requirements for corn and soybeans grown in rotation, the soybeans being utilized for seed production in one series and for hay production in another.**—Very much higher yields were obtained where the soybeans were picked for seed than where they were harvested for hay. Some of the plats, receiving incomplete fertilizer are showing extreme deficiency symptoms. Potash deficiency is worse on the plats receiving only nitrogen and phosphoric acid than it is on the no fertilizer plats. (E. R. Collins and C. B. Williams)

**Fertilizer requirements for corn, wheat and soybeans when grown in a three-year rotation (Toxaway loam).**—From this study it is apparent that omitting phosphoric acid from a complete fertilizer has caused a greater decrease in yield than has omitting either nitrogen or potash on this soil for the three crops. It is also apparent that a complete fertilizer is necessary for the production of the three crops on this type of soil. (C. B. Williams and W. H. Rankin)

**Rock phosphate, superphosphate and basic slag compared as sources of phosphoric acid for corn, wheat and soybeans in rotation (Toxaway loam).**—The data show that superphosphate has produced larger yields than have the other sources of phosphoric acid included in the experiments when equal amounts were used in a complete fertilizer. This project was discontinued with the wheat crop of 1937. (C. B. Williams and W. H. Rankin)

**A study of different treatments and methods of utilizing the legume crops after they are grown in three-year rotation (Hayesville sandy loam).**—The yields of wheat harvested in the summer of 1936 and corn harvested in the fall of 1937 show considerable differences in favor of leaving all legumes, both soybean and lespedeza on the soil, instead of cutting both off. Where potash was omitted from the fertilizer very severe symptoms of a condition generally accepted as potash deficiency were apparent on both corn in 1937, lespedeza in 1936, and soybeans in 1935. (C. B. Williams and W. H. Rankin)

**Fertilizer and lime requirements for cotton, corn, wheat and red clover when grown in four-year rotation.**—The data from the cotton crop of 1937 adds more evidence to that already obtained, viz: that phosphoric acid is more essential to be added than either potash or nitrogen in crop production on Cecil sandy loam, although all three are necessary.

From field observations and notes during the growing season of 1937, it is evident that "rust", a physiological condition of cotton which develops is corrected or improved by the use of potash salts. It was found to be more severe where limestone had been applied at the rate of one ton per acre every fourth year than where no limestone had been applied. Where superphosphate alone, or high percentages of phosphoric acid from superphosphate in complete fertilizers had been used, this same condition is more severe than where moderate or low amounts of superphosphate had been used in a complete fertilizer.

For red clover production, phosphoric acid and potash are both essential, as well as lime, as shown by the yield records of 1937 and those of preceding years. (C. B. Williams and W. H. Rankin)

**Rock phosphate, duplex basic slag, and superphosphate compared as sources of  $P_2O_5$  for corn, oats followed by soybeans, potatoes followed by soybeans on muck and peat soils.**—All the crops in this rotation on muck soil respond to applications of potash more than to either nitrogen or phosphoric acid. It has been noted year after year that where only phosphoric acid from superphosphate was used on soybeans, that the plant leaves die on the margins and shed early in the growth. As the phosphoric acid content of the fertilizer is increased, these symptoms become more severe. (C. B. Williams and W. H. Rankin)

**Study of sources and rates of application of different forms of lime for corn on peat soil when used with and without fertilizer.**—Ground dolomitic limestone is more efficient than the other forms of lime used in this study. The use of complete fertilizer with lime once every three years has increased the corn yields, but when used without lime the corn yields have decreased. Lime is a prerequisite for production of corn on this soil after two or three years of cultivation. (C. B. Williams and W. H. Rankin)

**Fertilizer and lime requirements for corn and soybeans grown in rotation, the soybeans being utilized for hay on one series and for seed in a second series.**—The soil condition for production of corn becomes less favorable unless potash is applied. The largest yields of corn are produced on plats that received high percentages of potash and low percentages of phosphoric acid. (C. B. Williams and W. H. Rankin)

**Effect of lime and potash on yield of corn when lime is broadcast at four-year intervals and when applied in the drill annually in one-fourth the quantity that is applied each four years.**—With four years' records on this experiment there is no indication from the results that any treatment of lime or potash used will correct the unproductive condition of this juniper peat soil. (C. B. Williams and W. H. Rankin)

**A study of potash deficiency on cotton on North Carolina soils.**—This work was conducted in cooperation with farmers in Northampton county. The results of this study were published in an Experiment Station bulletin and show that certain fiber qualities as well as yield were improved by supplementing the general fertilizer practice, 400 pounds 3-8-3 per acre with 25 and 50 pounds of potash as a side application at first chopping of the cotton. (C. B. Williams and W. H. Rankin)

**A study of fertilizers made from base goods (ammoniated phosphates).**—In this study a comparison is being made of the relative value of applying all the nitrogen derived largely from base goods made by the use of liquid ammonia and applied at planting time as compared with applying two-thirds of the nitrogen at planting time with the phosphoric acid and potash and reserving the other third to be applied as a side application immediately after chopping. (C. B. Williams and W. H. Rankin)

**Studies on breeding for improvement of corn varieties.**—The inbreeding program begun in 1936 was continued in 1937, with 263 selfed lines from

14 varieties of southern corn being grown. From this work 510 selfed ears were saved for planting in 1938. Most of these varieties are prolific, and it was planned to self pollinate one ear and top-cross the second, but due to extreme hot, dry weather during the pollination season the second ear on the stalk (on which the top-crosses were made) failed to develop in most cases, and none of these were used in 1938.

In addition to the selfed lines from southern varieties, a collection of inbred lines was secured from Corn Belt states and from the Office of Cereal Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture, and planted in the spring of 1938. In all about 1000 selfed lines were planted this spring.

Work is being continued on the yellow-white crosses previously made by P. H. Kime of this department, with a view of developing a pure synthetic yellow variety similar to the white parent variety in growth habit.

Preliminary tests were also started between local varieties and about 50 hybrids representing the best from the above sources.

**General Conclusions.**—Due to the lack of any satisfactory land on the Central Experiment Station on which to carry on this work, four acres were rented from the Whitley-Davis farm, Clayton, in the spring of 1938. This farm is 21 miles from the College. This soil grew a fine crop of corn, but due to the expense and loss of time in making almost daily trips during the pollination season this arrangement was not entirely satisfactory. It is hoped that in the future better arrangements can be made. (G. K. Middleton and P. H. Harvey)

**A study of sweet corn adaptability.**—Sixteen varieties of sweet corn were on test in 1937, and twenty-two in 1938. Also a latitude test with several varieties of sweet corn was carried on in cooperation with the Connecticut Agricultural Experiment Station. (Robt. Schmidt)

**Corn Earworm.**—Earworm control experiments were conducted on two plantings of Red Green Hybrid sweet corn, the first harvested July 31 to August 11, 1938, and the second harvested September 4 to 7. On the first planting all treatments were applied three times, July 18, 22, and 27. Six treatments were duplicated on silks clipped off just below the tip of the husk. In every case the clipped rows showed a higher percentage of worm free ears, as compared to unclipped ears having the same treatment. Clipped check rows had 39% and 64% worm free ears; unclipped checks, 8%, 29% and 35% worm free ears. Lead arsenate, with and without a wetting agent, was applied to silks with a small sponge. All such treatments showed a much lower percentage of worm free ears than the same material applied with a solid stream jet, 1/32 inch in diameter. Highly refined mineral oil (medicinal) applied with an oil can gave the best results, 100% worm free ears on clipped silks, 88% worm free on unclipped silks. This oil caused no injury and could not be tasted on the ears. Lead arsenate 1 to 400, with Tergitol wetting agent 1-1000 and 1-2000 gave 96% and 92% worm free ears on clipped silks, and 61% and 76% on unclipped silks. A less highly refined oil in emulsion form gave good control, all over 90% worm free, but caused considerable injury and imparted a slightly oily taste to the ears.

On the second planting refined mineral oil was used in one, two and three applications, on both clipped and unclipped silks. At this time the

corn became severely infested with earworms and fall army worms, and all treatments gave very poor control. Little difference was shown between clipped and unclipped ears, in most cases the unclipped ears showing slightly better control. The control with mineral oil increased with the number of applications, but the best row gave only 39 % worm free ears, with an average of 9 grains per ear destroyed. The check rows had from 4 % to 0 % worm free ears, with averages of from 27 to 37 grains per ear destroyed.

The mineral oil treatment is easy to apply and shows promise of giving very satisfactory control under conditions of moderate infestation, such as usually occur during July and often during the first part of August. (B. B. Fulton)

## GRAIN STUDIES

**A study of values of winter hardy oats.**—The Lee strain 5 showed the greatest gain over the check variety (Lee) in our main oat yield test at Statesville with the exception of one winter-hardy Fulghum selection from Tennessee. This selection of Lee oats has outyielded the parent variety in each of the past six years, the average annual gain being 6.2 percent. It was first distributed from the Piedmont Branch Experiment Station in the fall of 1937. Its yield in comparison with other varieties is shown in Agronomy Information Circular 110, issued in September, 1938.

The first generation from crosses of non-fatuid producing strains of Russian oats and certain American varieties was grown in the greenhouse at Raleigh during the winter of 1937-38. It is planned to grow the second generation in the field in the spring of 1939.

**Some General Conclusions.**—Winter-hardy varieties, carrying resistance to smut and crown rust, are desirable for the Piedmont area of the state. With this in view the 56 selections from crosses of Lee x Victoria and Hairy Culberson x Victoria, secured from the Office of Cereal Crops and Diseases, U. S. Department of Agriculture, in the fall of 1936 were all carried in the main yield test this year. Of this group 12 yielded slightly in excess of the check variety, which is most encouraging. (G. K. Middleton and W. H. Chapman)

**A study of values of winter hardy barley.**—Bearded Selection 15 led the yield test at the Piedmont Branch Experiment Station this year, and has the highest seven-year average of any variety or strain at this station. During this period it has averaged 37.4 bushels per acre as against 29.9 for Tennessee Winter, the standard bearded variety for this region. Selection 15 is from a Composite Hybrid received from the Office of Cereal Crops and Diseases, U. S. Department of Agriculture, and first selected out in 1930. About 400 bushels were grown this year for distribution in the fall of 1938.

Smut inoculation tests started in the fall of 1936 were continued, as was the growing of hybrids made for smut resistance. About 40 new hybrids were also made.

**Some Findings.**—Outstanding results and observations from this project are: (1) high yielding capacity of Selection 15; (2) good indication of smut resistance in certain selections; and (3) interesting observations



on the relationship between winter-hardiness and certain plant characters. (G. K. Middleton and W. H. Chapman)

**Breeding for disease resistance and winter-hardiness in North Carolina wheats.**—The earlier strains of wheat outyielded the later ones in the tests at the Piedmont Branch Experiment Station this year. This was probably due to rust which affected the later ones most. This difference seems to have held true, in general, for those selections which have been in the test for the past six years. During this period two strains of Alabama Blue Stem have led the test, and have been followed by Redhart. These have been the three earliest sorts in the test. Alabama Blue Stem 89 is being increased for distribution in the near future.

In the tests this year there was a total of 45 strains, 15 of which were from local varieties, 5 from the Georgia Station, and 20 selected from hybrids between local and rust resistant varieties. The fact that 12 out of the 20 new selections outyielded the check variety is most encouraging.

The cooperation with the Office of Cereal Crops and Diseases, U. S. Department of Agriculture, was continued this year on the following two projects: (1) the growing of five standard varieties of soft winter wheat to be used for milling and baking tests in the Federal Laboratory at Wooster, Ohio, and (2) by conducting a unit of the Uniform Winter-Hardiness Nursery at the Mountain Experiment Station.

Fulcaster 151 was distributed from the Mountain Station for the first time in the fall of 1937. This selection has averaged 1.0 bushel more than the check variety (Fulcaster 44, or Nittany) at Statesville for the past six years. Fulcaster is largely used in this area of the state by wheat growers. (G. K. Middleton and W. H. Chapman)

## PEANUT STUDIES

**Some studies of causes of root rot of peanuts.**—Since peanuts are grown in rotation with many other important crops, including tobacco, cotton, soybeans, sweet potatoes, and are attacked by fungi and bacteria that are being studied in a project on root rots, it was found desirable to use the peanut, to some extent, in carrying out these studies. The peanut lends itself well to both laboratory and field studies more satisfactorily than do many of the other crops. A method has been devised for carrying out inoculations of health peanuts in the laboratory and studying the activity of the parasites on plants subjected to various temperature conditions. Large test tubes were used in which the peanut was germinated and tested for freedom to infection before inoculations were made. The healthy nut was obtained by immersing shelled nuts in 1-1000 mercuric chloride solution for one minute, and by peeling the thin periderm tissue from the meaty part. The test tube is kept sterile with heavy cotton plugs. Some remarkable findings have been obtained in this way. Our results tend to show that growers are planting diseased seed in a great majority of the farms. (Fig. 1). They also show that the root rot problem is a complex one, and may under different conditions result from a great variety of organisms. (Fig. 2). The laboratory studies indicate very definitely that exhaustive studies of varietal resistance, crop rotation and soil treatment may be required for the improvement of peanuts and the reduction of

losses caused by organisms that produce root rots. These types of experimentation are under way.



Fig. 1.—Example of diseased peanuts used widely for seed.



Fig. 2.—Typical example of diseased peanuts removed during the regular harvest season.

Many isolations were made from the infected parts. Among the large number of fungi isolated were well known and widely distributed ones, including *Pythium ultimum*, *Sclerotium bataticola*, *Botrytis cinerea*, *Corticium vagum*, *Fusarium vasinfectum*, *Sclerotium rolfsii*, *Rhizopus nigricans* and *Fusarium moniliforme*. There were apparently many species of *Fusaria* isolated, which are not as yet identified. At least five distinct morphological strains of *Corticium vagum* were isolated. *Sclerotium bataticola* was obtained from all sources where samples were taken. Species of *Cephalothecium*, *Trichoderma*, *Penicillium* and *Aspergillae* were also obtained.

Preliminary studies on plant inoculations have clearly shown that a very large number of the *Fusaria* isolated from the lesions on the nuts as well as the established parasites given above are parasitic on the peanut plant and its various parts under favorable conditions. (Fig. 3). It was



Fig. 3.—Types of root rots on juvenile plants caused by several organisms.

revealed in these studies that *Sclerotium bataticola* attacks around 28 C but not at 18 C. One strain of *Corticium vagum* attacked at 28 C. and higher only, while another strain attacked at about 18 C. and lower only. The other three strains seem to work in intermediate temperatures. *Botrytis cinerea* attacked at low temperatures. *Sclerotium rolfsii* was isolated from one source only, indicating that it may possess greater soil borne than seed borne activities. Some fungi caused discoloration and apparent injury to the roots without actually attacking the tissues. (R. F. Poole)



**The biology of the peanut leafhopper.**—A considerable portion of the time allotted to this project was devoted to a study of the relations of this pest to its native and cultivated food plants, in an effort to arrive at satisfactory methods of control. There is apparently a very large shifting population of this leafhopper which migrates from native weeds to potatoes, from potatoes to peanuts and garden beans, and from peanuts and garden beans to soybeans and cowpeas, but as yet we have not been able to work out a method which will carry our rough field observations over into the field of experimental proof.

The rest of the time allotted to this project was spent in a series of dusting experiments to find a satisfactory insecticide for the control of the peanut leafhopper. Small plots duplicated were dusted with eleven insecticides. Of the materials tried pyrethrum with sulphur as a carrier at the rates of 15 percent and 30 percent pyrethrum, cube 15 percent with sulphur and bordeaux gave the most promise. It is our plan to carry out further experiments with these materials next year. (Z. P. Metcalf)

**Effect of breeding, selection and spacing upon yield and quality of peanuts.**—Total yields of different spacings tended to increase as number of plants per unit were increased. The spacings under observations had little effect on the grade and class, but the yields of handpicks were positively correlated with the total yields of unshelled nuts.

Yields of different strains of Virginia Bunch peanuts ranged from 1336 to 1700 pounds per acre. Strain Number 5 was the lowest yielding strain and also the lowest in percentage of handpicks produced. The yields of total handpicks varied from 758 to 1144 pounds per acre. Cooperative work with four representative growers in the peanut belt of the state indicated great differences between the quality of selected strains and farmers' seed stocks. Some of the selected strains seemed to be less susceptible to southern root rot than farmers' stocks, although such observations were not always consistent. Spanish, Valencia, Tennessee Red and Tennessee White were more susceptible to southern root rot than the selections of Virginia Bunch.

**Some Results.**—The improved strains of Virginia Bunch peanuts referred to above have been continued in the yield tests in 1938 at the Upper Coastal Plain Station along with four strains from the Holland, Virginia Station, 2 from farmers, and with Valencia and Tennessee Red. Two of the better of these (strains Nos. 8 and 31) are also being tested against three lots of farmers' stock seed in Edgecombe and Bertie counties.

In addition to these two tests, twenty varieties and strains were planted out for observation at three outlying points where peanut diseases were serious in 1937. The purpose of this work is to learn if any strains show resistance to these diseases in order that they may be used in our breeding program.

Through the cooperation of the Division of Horticulture, Bureau of Plant Industry, U. S. Department of Agriculture, 106 new introductions were secured and planted in preliminary tests at the Upper Coastal Plain Station. (G. K. Middleton and P. H. Harvey)

**Studies on the effects of fertilizers on peanut production.**—The application of gypsum to the foliage has consistently produced the highest yields and highest percentages of handpicks and of shelled nuts. Increasing the

quantity of lime applied increased the yield, the lime applications being more effective in 1937 than in 1936. There was no apparent relation between pH and yield. The application of a 2-8-4 fertilizer increased yields slightly, possibly on account of its calcium content. Thus far the plats in the peanut, corn-soybean, and cotton rotation have produced no more than the plat receiving the same quantity of limestone but being grown continuously in peanuts.

On the plants of the new series, vines were larger, "pegs" more profluse, maturation later, and yields less than on the plats which had been in cultivation three years and which had also received lime and gypsum. On this series the plats limed to pH 5.5 produced slightly more shelled nuts than those limed to pH 6.5. There was no apparent difference in the plats receiving 0-8-4 and 0-8-8 fertilizer. (E. R. Collins and N. E. Rigler)

## SOYBEAN STUDIES

**A study of soybean varieties.**—Hay yields from the 11 varieties ranged from 1532 to 3810 pounds per acre. The Pee Dee, Ludeke and Ootootan were the leading hay varieties; the Pee Dee yielded approximately 800 pounds more than Ootootan, a recognized hay type for eastern North Carolina.

Seed yields ranged from 5.2 to 15 bushels per acre. Nanking, Herman and Mamredo were superior seed producers, but the Large Seeded Tokio has outyielded all three of them when calculated on a 5-year basis.

Several Mammoth Yellow x Biloxi hybrids outyielded either parent and did not shatter as readily as the Mammoth Yellow. These hybrids are not yet homozygous for this character.

Preliminary yields were taken on 28 of the soybean introductions being grown at this station. The following strains show some promise for seed purposes: Nos. 21002, 82591, 85470, 85888 and 86920.

The following strains showed some promise as hay types: Nos. 80436, 82591, 83947, 84699, 86920, 88536-3.

Cooking trials, as indicated by palatability, cohesion of cotyledon, color, texture and skin toughness, have been determined for 16 strains. None of the introductions tested have been superior to the Hahto and Rokusun. (R. L. Lovvorn)

## CROTALARIA STUDIES

**Studies of the utilization of crotalaria species under Coastal Plain soils and cropping conditions.**—Corn yields have been almost doubled by growing crotalaria in alternate years in the rotation. Second year corn yields in a rotation of crotalaria-corn-corn have been much lower than the first year yields. Fertilizing the crotalaria has had little if any effect on the corn yields. Harvesting the crotalaria seed has had no effect on the corn yields. The frequency with which crotalaria occurs in the rotation has influenced the yield of seed.

Utilizing crotalaria in the rotation has not significantly increased the organic matter, available phosphoric acid, exchangeable bases or the water holding capacity of the soil in any of the cropping systems being investigated. (R. L. Lovvorn)

## PASTURE AND GRASS STUDIES

**A study of different types of phosphates on pasture grasses.**—The object of these experiments is to determine the relative efficiency of triple superphosphate, calcium metaphosphate, and fused rock phosphate at different phosphoric acid levels in combination with different amounts of dolomitic limestone in the production of pasture grasses on one of the dominant upland pasture soils of the mountain area, and to determine the efficiency of triple superphosphate and limestone when used with or without nitrogen and with or without potash at different phosphoric acid levels in the production of pasture grasses on the same soil. No results will be obtained until the spring of 1939. (W. W. Woodhouse)

**Acid Tolerant Legume and Grass Nursery.**—Detailed observations have been made on a number of miscellaneous legumes and grasses. The cro-talarias, subterranean clover, hairy vetch, Austrian winter peas and lespedeza sericea have been found to be most promising.

Perilla ocymoides was superior to the purple red strain of Perilla markinensis. Chia produced no seed during the growing season of 1938.

Some differences in growth habits occurred among the 54 alfalfa strains planted in the fall of 1937. None of the strains produced good stands because of dry weather at planting. (R. L. Lovvorn)

**Environmental factors affecting the establishing of permanent pastures in the Coastal Plain Area.**—No yield data were obtained in 1937 from the permanent pasture study that was begun in the spring of that year. Vegetative analyses were made of the sward by the inclined point quadrat method. None of the species, individually or collectively, produced any significant increase in growth as a result of soil treatment. Differences between species were highly significant. Bermuda grass and Kobe lespedeza produced much more growth than any other species. The competitive effect of lespedeza was noticeable in decreasing the growth of all of the grasses studied. There was no significant difference between replications, indicating that for the purpose of this experiment three replications are sufficient.

Population studies on pasture species needed on a muck soil at the Blackland Branch Station in 1934 and again in 1937 showed that manure was more influential than any other fertilizing material in increasing the growth of tame grasses. Copper sulfate produced no significant increase in the population of grasses or legumes. Bermuda grass, Reed canary and Orchard were the most promising grasses. Kobe lespedeza and white clover were the only legumes that produced satisfactory growth. Kentucky bluegrass is the only surviving species of a mixture of redtop, bluegrass, white clover and common lespedeza seeded in 1934. (R. L. Lovvorn)

**A study of pastures and their utilization by sheep.**—This study, as reported last year, was repeated on the same three fields of four-acres each.

The grazing from these fields from June 24, 1937 (weigh day) to July 1, 1938 (weigh day), was as follows:

**Permanent Pasture:** Permanent pasture from June 24 to November 4, 1937, and from March 25, 1938, to July 1, a total of 231 days grazing.

**Korean Lespedeza and Abruzzi Rye:** Korean Lespedeza from June 24 to September 23, 1937, and from June 17 to July 1, 1938. Abruzzi Rye from October 21 to November 18, 1937, and from February 25, 1938, to May 4. This gave 105 days grazing on lespedeza and 96 days on rye, or a total of 201 days for the combination.

**Korean Lespedeza and Italian Rye Grass:** Korean Lespedeza from July 15, to August 26, and from September 9 to September 23. Then from June 17 to July 1, 1938. Italian Rye Grass from November 4 to November 24, 1937, and from March 11, 1938, to April 22. Then from April 29 to May 20. This gave 70 days grazing on lespedeza, and 83 days on rye grass; or a total of 153 days for the combination.

For the periods given above the following grazing days were obtained:

**Permanent Pasture:** Sheep grazing days 2,212 and nursing lamb grazing days 835.

**Lespedeza and Rye:** Sheep grazing days, 2,007, and nursing lamb grazing days, 928.

**Lespedeza and Rye Grass:** Sheep grazing days 1,670 and nursing lamb grazing days, 831.

The comparative results were very similar to those reported the preceding year. There was no significant difference in the condition of the sheep on the two annual pastures. However, during the winter season these groups made considerably greater gains, and required much less hay than the permanent pasture group which was on dry feed. Then too, during the latter part of the grazing season when the permanent pasture had become tough, the groups on lespedeza were in higher condition. (J. E. Foster, R. E. Stitt and E. H. Hostetler)

**A study of the value of native reeds (*Arundinaria tecta*) for grazing.**—Native reeds were the chief source of pasture for the beef herd at the Blackland Station, Wenona, from spring to mid-winter.

The cattle were turned in the reed pasture on May 11, in 1937. On this date 29 grade Hereford and Native cows and their 25 grade calves, 17 grade yearlings, 17 grade two-year-old heifers, and a Hereford bull were turned on this pasture. On June 30 six more similar yearlings were turned on the reeds, and on July 28 the bull was removed. The calves and 12 yearling steers were taken out on November 17.

From May 11 to November 17, a period of 190 days, the average daily gains for the different groups were as follows: Cows (25 of which were nursing calves), .4 pound; calves, 1.2 pounds; yearlings, .7 pound; and two-year-olds, .9 pound. The bull only lost 20 pounds during the breeding season from May 11 to July 28.

In addition, ungrazed reed areas more than maintained the weights of the cows, two-year-olds, and yearling heifers from November 17 to January 28, 1938.

The cows and bred heifers were moved to the farm on January 28, but the winter was mild and the unbred heifers, those born spring of 1936, were left in the reeds all winter. From January 28 to May 6 these two-year-old heifers made an average daily gain of .6 pound.

All of the cattle were turned back on reed pasture on May 6, 1938. (J. E. Foster and E. H. Hostetler)

**Comparative study of gains on reed versus tame pasture.**—In 1937 a repetition of the tests of preceding years was started, but was discontinued on the tame pasture on June 30, due to a drouth.

On April 29 six yearling steers and heifers were turned on the tame pasture. From then until June 30, a 62 day period, they made an average daily gain of 2.2 pounds.

Seventeen similar yearlings were turned on the reed pasture on May 11, and for the 50 day period to June 30, they made an average daily gain of 1.7 pounds.

This has been the approximate results of former years. Although the tame pasture produces more rapid gains during good seasons than the reed pasture, it is much more subject to injury by drouth. For example, in the above case the reeds continued to furnish fair grazing throughout the season.

One-half of the tame pasture was plowed up in the late fall of 1937 and no cattle are being grazed on tame pasture in 1938. (J. E. Foster and E. H. Hostetler)

**A study of the value of crop gleanings for wintering beef cattle.**—In 1938 (the eighth year of gleanings studies) the cow herd, which consisted of 25 cows and 13 three-year old heifers, was turned in the corn stalk and soybean fields on January 28. These cattle were also given access to rye grazing at this time, but no harvested feed was fed until April 4. Corn silage and corn stover were fed intermittently, when grazing was not available, from April 4 to May 6, at which time the herd was returned to the summer pasture.

All 38 of these cattle calved (one calf drowned) and, as in former years except for loss in weight at calving, practically maintained their weights and produced rapid gains in their nursing calves. The combined weight of the cows and their calves on May 6 was 2,425 pounds greater than the weight of the cows (38 head) on January 28. This resulted in an average increase per head of approximately 64 pounds.

In addition, the stalk fields and rye pasture furnished the entire roughage (except for 8 days following weaning) for 20 weaned calves from November 17, 1937, to January 12. Only 50 pounds of cotton seed meal per day in addition were fed during this period, but the average daily gains per head were approximately .8 pound.

As in the previous years, some roughage and grazing were also available for the weaned calves throughout the winter, which greatly reduced the amounts of harvested feeds required. (J. E. Foster and E. H. Hostetler)

## PEACH STUDIES

**Further studies on the effects of fertilization on the control of Bacterial Spot of peach caused by *Bacterium pruni*.**—In experiments with 0, .5, 1, 2 and 3 pounds of  $K_2O$  in Kainit, manure salts, muriate of potash and sulfate of potash, it was shown that these large amounts of potash salts did not control the bacterial spot. The data indicate that it had no direct effect on increasing or decreasing the infestation. But when as much as one pound of  $K_2O$  was used along with magnesium applied in the form of magnesium sulfate, at the rates of one and two pounds, there was both



direct and indirect effects on control. Because of lack of sufficient infection in the experimental plats, it was impossible to evaluate the results for a definite conclusion, but the magnesium treatments not only reduced the amounts of infection and induced greater power of retaining the foliage. In orchards where 1400 to 2000 pounds of high grade fertilizers have been applied every year the production of high quality fruit has always been much greater than in orchards that have received small amounts of fertilizers, mostly nitrogen compounds. (Fig. 6). The bacterial spot



Fig. 6.—Peach trees that have been generally infected with *Bacterium pruni*, but have produced much first class fruit. They have been fertilized with 1400 pounds high analysis fertilizer in the Spring every year.

has developed in highly fertilized trees, but serious injury to the fruit and defoliation has been insignificant. In orchards where the root rots have been of minor importance the heavy fertilization has greatly increased the life of the tree. It is definitely shown that heavy fertilization is an important consideration in any approach to the control of *Bacterium pruni*. (R. F. Poole)

Further studies of the effects of various copper compounds on the control of the bacterial spot of peach caused by *Bacterium pruni*.—Some time has been devoted to determining the effects of the copper materials, such as copper phosphate, copper silicate, red cuprous oxide, #54 copper zeolite, and compound #26 on the foliage and fruit of the peach. While compounds of these materials varied in metallic copper content, tests indicate that they can be safely applied to foliage of the peach when equal quantities of lime are used in the spray mixture. All of these compounds have been applied at rates from one to three pounds in 50 gallons of water. When used with cotton seed oil serious injury occurred on twig, foliage, and fruit. This was especially noticeable on trees that were deficient of adequate nutrients for progressive growth. Trees that had been highly fertilized and had made rapid growth were not injured severely. In one orchard where gradation of growth was pronounced, there was also a pro-



nounced increase in injury from the trees with good to poor growth activities. Likewise, old trees 20 to 25 years of age showed less tolerance than young trees 4 to 6 years of age.

The bacterial spot was so slight and irregular in the three orchards where experiments were conducted that conclusions on the effectiveness of the chemicals on the control of the organism could not be obtained. In fact, the disease was insignificant on the fruit, and the three periods at which leaf infection occurred slightly did not result in marked defoliation at any time.

The character of the injury produced by these various copper compounds is worthy of recording at this time. The injured tissue is specific and well demarked. The tissues are dehydrated, turn purple, die and fall out leaving various sizes of shot holes where the coarser particles lodge. The fine particles cause the development of a purplish-red color on the under side of the leaf. After severe injury defoliation may be serious, but the trees maintain considerable resistance to defoliation, because the injury is localized. Many leaves severely injured as early as June remained on the trees until the middle of November. There has not been any permanent injury produced even when trees were completely defoliated with strong Bordeaux mixture. (R. F. Poole)

#### **A study of peach fertilization in the Piedmont.—**

1. Nitrogen alone has given highest total yields over a four year period, but color and quality have been poor in comparison with other treatments.

2. Trees receiving a complete fertilizer (NPK) have yielded fruit of better color and a higher percentage of desirable grades.

3. Terminal growth measurements give preference to the complete fertilizer.

4. Circumference increase has been greatest on the high nitrogen plots (N alone) but followed closely by plots receiving complete fertilizer. The differential is slight.

5. Remarkable vigor is shown by the use of P and K (applied to trees) with fertilized and unfertilized cover crop.

6. Harvesting continued for eight days on high nitrogen and complete fertilizer plots, and four days on plots receiving phosphorous and potash alone with fertilized and unfertilized cover crop. (M. E. Gardner)

**Fruit quality studies of Peach.**—Data collected on approximately five thousand fruits over a period of three years were analyzed for statistical significance. These data represented measurements at harvest of fresh fruit weight, fruit circumference, seed weight, and fruit firmness as determined by the pressure tester. The data were grouped according to treatment given the trees from which the fruits were harvested.

Statistical treatments included analysis of variance of fruit weight and of seed weight according to plot treatment, calculations of correlation between fruit weight and seed weight and calculation of the regression of fruit weight. The statistical analyses are at present incomplete.

From analyses which have been completed the following general conclusions are drawn from these studies:

(1) For a given tree the fruit and seed weight are both largely determined by the relative vigor of the tree and by the location of the fruit on the tree.

(2) Thinning increases the proportion of fruits of high fruit and seed weight. This increase is probably accomplished by the actual removal of small sized, small seeded fruit rather than by the stimulation of fruit and seed growth as a result of thinning. This latter alternative might be induced by extremely heavy reduction in fruit load at a very early stage of fruit development. (Ivan D. Jones)

**Studies of effects of boron on peach.**—Symptoms of boron deficiency have occurred on other crops in this area. Boron is being tried in combination with fertilizer practices and liming on peach trees of different ages. Measurements of amount and quality of growth have been taken. Moisture and temperature conditions were especially favorable this year during the growing season. Satisfactory growth and yields were secured on all plots. A preliminary inspection of the data secured shows no outstanding differences between treatments. (C. F. Williams)

**Peach root development studies.**—These studies are being made on trees grown in corrugated steel tanks. The tanks are seven feet in diameter, six feet deep and fitted with concrete floors. Provision is made for the removal of water from the bottom of the tanks in order to prevent the establishment of a water table. Soil for filling the tanks was obtained from the commercial peach orcharding section of the Sandhills.

The following differential treatments were made the past season:

- (1) Two tanks with trees and an unmowed crabgrass cover.
- (2) Two tanks with unmowed crabgrass cover—no trees.
- (3) Two tanks with trees, and with crabgrass cover mowed at frequent intervals.
- (4) Two tanks with trees—no cover.
- (5) Two tanks, no trees, no cover.

Observations included soil moisture determinations at different levels in the tanks and at intervals during the growing season; collection of rainfall records, and removal of excess water sufficiently often to prevent accumulation. Also tree growth measurements were taken.

Tree growth differed greatly according to treatment given the tanks.

Trees in tanks receiving clean cultivation grew satisfactorily, while those in tanks having a crabgrass cover exhibited low vigor as indicated by poor leaf color, early defoliation and restricted growth of branches. In tanks with unmowed cover, tree growth was inferior to that in tanks in which the grass was mowed.

Soil moisture determinations at critical periods during the growing season indicated that moisture was not a limiting factor during this season.

These determinations further indicate that the crabgrass cover utilized a large portion of the rain which fell during the period of active growth, and also that moisture withdrawal by the grass occurred to at least a depth of four feet. (Ivan D. Jones, Otto Veerhoff)

## APPLE STUDIES

**Studies of some apple problems.**—The General Assembly of 1937 appropriated \$10,000 for apple research in the Brushy Mountains. The apple

growers took an active part in support of this appropriation and were largely responsible for final approval. Incidentally this is the first direct appropriation ever made by the legislature for the support of research in any field of agriculture in the state.

In October, 1937, the work of establishing the laboratory was begun. A very desirable site was deeded to the state by Mr. E. P. Lowe, of Pores Knob, one of the oldest and best known apple growers in the section. On this site a laboratory building and garage were erected and equipped, and a full time man placed in charge.

For spraying experiments an orchard sprayer with three compartments of one hundred gallons each was purchased, and mounted on a one and one-half ton truck. This outfit worked very successfully even in quite rough orchard land.

An orchard of seventy bearing Limbertwig apple trees was selected and divided into nine blocks. With the exception of two blocks a different one of the regular sprays was omitted from a different block. On five blocks an extra spray was applied at the pre-pink stage. The apples from each of these blocks are counted for scab, blotch rot, cedar rust, stippen, scale, and codling moth worms and stings at harvest time. A few of the most promising new spray materials are being tried out in test blocks in several orchards.

Numerous tests are being made with lime and phosphate for the improvement of lespedeza. A few tests are being made with a nitrogen fertilizer with a lime base. *Lespedeza sericea* is being tried out in alternate strips in a number of orchards.

Bait pails for codling moths were put up in several orchards during May to collect moth larvae from bands on the trunks and main limbs of apple trees in several orchards. These larvae were placed in small cages which have a wire screen bottom and allowed to develop adult moths in order to study the time of emergence periods. (Carl E. Van Deman, M. E. Gardner)

**Studies of Newer apple varieties.**—Cions from several of the newer varieties of apples were secured and a few trees in a number of orchards were grafted to these varieties. A small number of trees of other newer varieties will be purchased and set out in some of the recently planted commercial orchards. (Carl E. Van Deman, M. E. Gardner)

**Apple variety studies.**—The Close apple, U.S.D.A. No. 57, has been added to the recommended list for the state as a result of tests at Swannanoa. It is a promising and desirable early red, maturing in approximately the same season as Yellow Transparent.

Variety studies are being continued in order that a large collection may be kept under observation for adaptability, possible commercial value, and breeding. (M. E. Gardner)

## PECAN STUDIES

**Studies on Pecan breeding.**—As a result of the work done on this project a very promising seedling has been selected and propagated and will be distributed in 1939. (Robt. Schmidt)

## BERRY STUDIES

**Raspberry and Dewberry breeding studies.**—In dewberry breeding the following characters were studied during the past year: Thornlessness, cluster size, disease resistance, and fruit quality. Inheritance studies are difficult as these species are polyploid and many of the crosses are between species of different chromosome numbers and much sterility occurs in seedlings. Data on inheritance of thornlessness have been secured on over two thousand seedlings. This year seed have been collected from several selfed thornless seedlings. From two seedlings having large fruit clusters, several seedlings with this character have been bred. All selfed seedlings of Young, Boysen and Acme were very susceptible to leaf spot diseases as were many of the crosses with these varieties. A high percentage of dwarf seedlings was found among the seedlings of certain crosses.

Hybridization of American raspberries with foreign species to obtain varieties adaptable to the Coastal Plains is proceeding as rapidly as possible. Eighteen different foreign species and introductions are now growing at Raleigh although several have failed to come into bloom.

Hybrids of the trailing raspberry, *R. parvifolius*, were outstanding for vigor, disease resistance and fruit size. Back crosses of hybrids of *R. biflorus* show improvement in fruit size, quality, and earliness, and many retain much of the vigor and disease resistance of the Asiatic parent. A selection of *R. biflorus* x Chief crossed with Lloyd George produced eleven seedlings with yellow fruit and three with red, five not fruiting. Seedlings of a selection of *R. biflorus* x Cumberland back crossed with Cumberland were all of good fruit qualities.

Studies are being conducted with colchicine. No apparent effect has been produced when used in strengths up to two percent on growing points and buds of older tissue. Weaker strengths when used on small seedlings produced some stunting and malformation on about thirty percent of the seedlings (total four hundred). Many of these failed to survive when set in the field.

Mulching has been used as a cultural method on some of the raspberry plantings with excellent results in growth, fruiting, reduction of defoliation, and longevity of plants. (C. F. Williams)

**A study of dewberry fertilization and food storage.**—With Lucretia dewberries in the Sandhills much of the trouble of dying of fruit canes at harvest and loss of plants appears to be related to soil conditions and fertilizer practices. Differential summer pruning continues to favor the practice of complete removal of all canes after harvest. (C. F. Williams)

**A study of raspberry fertilization.**—Results are comparable with those secured in 1937. Stable manure applied at the rate of ten tons per acre continues to lead all other nutrient combinations in yields. This is due in part, perhaps, to the additional moisture conserved by the straw in the manure. (M. E. Gardner)

**A study of the relation of spacing to growth and fruiting of the strawberry.**—Spacing Studies: The spacing work at Willard included the following comparisons: Single-row, double-row, triple-row, and matted-row beds on Blakemore, Missionary, N. C. 669, and N. C. 419; early-rooted and

late-rooted single rows on Blakemore, N. C. 669, Fairfax, N. C. 419, and Missionary; and renovated beds compared with old beds on Blakemore. Records were secured during the 1938 harvest season on yield and grade of berries from plots fifty feet long replicated three times. In general, the highest yield of No. 1 berries was obtained from the triple-row beds.

**Runner Length Studies;** Runner length measurements were started in 1936 and continued during the 1937 and 1938 seasons. Data for the first two seasons were published in the 1937 Proceedings of the American Society for Horticultural Science. The results to date indicate that varieties with medium to long runners such as Blakemore, Klondike, and Missionary lend themselves to desirable spacing systems better than varieties with short runners such as Premier and Dorsett.

**Blueberry breeding.**—This project was designed to continue the blueberry breeding work started by the late Dr. Coville. Approximately five thousand seedlings planted by Dr. Coville at Atkinson will fruit for the first time during the 1939 season. Some four thousand seedlings from crosses made by the United States Department of Agriculture have been planted in nursery rows at Magnolia and will be set out in the field during the winter of 1938-1939. (E. B. Morrow)

**Effect of soil factors, fertilizers, lime and crop sequence on plant viability, production, time of maturity and quality of strawberries (In cooperation with the Federal Bureau of Plant Industry).**—Four year rotations, at two locations, including cash and cover crops, inaugurated in 1936, were planted to strawberries and the first yield records will be obtained this coming year.

Each four-year rotation includes two cropping seasons for strawberries and includes such crops as cowpeas, Sudan grass, lespedeza, sweet potatoes, snap beans, velvet beans, soybeans and oats appearing in the rotations in different orders and with different fertilizer practices.

Studies on the relationship of soil acidity to plant viability, yield and quality of strawberries showed that on an acid soil the yields were increased from 2409 to 2707 quarts per acre following the application of limestone. This confirms previous results that acidity is an important factor in plant vitality and yield of strawberries. Results from the study of the time of application of fertilizers to strawberries were in favor of a split application with one-half of the fertilizer applied the first of September and the other half applied the first of January. (E. R. Collins, N. E. Rigler, J. J. Skinner, and R. A. Lineberry)

## IRISH POTATO STUDIES

**Irish potato breeding studies.**—A severe epidemic of late blight occurred in the summer of 1938, the first since the breeding investigations were begun. This gave an opportunity to observe the resistance of seedling selections to the disease under field conditions. Since breeding for resistance to late blight is one of the major objectives of the breeding program, careful field notes were made on all material planted at Jefferson.

Particular interest centered around seedling No. 130.5-24 since this selection has given outstanding yields over a period of five years. Under the severe blight epidemic conditions which prevailed the disease was of no commercial importance on this selection while vines were completely

killed on a large percentage of other selections and varieties under test. This selection has also shown marked resistance to flea beetle and leaf hopper injury which annually cause a reduction in yield of from one-third to one-half of the Irish potato crop in Western North Carolina. Under the adverse weather condition prevailing during the 1938 growing season 130.5-24 produced four hundred fifty-four bushels per acre.

Approximately eighty bushels of foundation seed stock of 130.5-24 was grown in 1938 and will be isolated for registered seed stock to be distributed to growers in 1939. In the meantime a name will be selected for the seedling and introduced to the commercial trade.

In addition to the tests made in North Carolina, Maryland, Maine, South Carolina, and other states have given favorable reports on the performance of this selection under their climatic and soil conditions.

Approximately seven thousand seedlings were grown in the greenhouse in 1938 and about one thousand selections and varieties were studied in the field. (M. E. Gardner)

## SWEET POTATO STUDIES

**A study of the perpetuation of strain selection of sweet potatoes.**—The seed stock of N. C. Strain No. 1 Porto Rico sweet potato is being kept up to a high standard by careful hill selection. (Robert Schmidt)

## CABBAGE STUDIES

**Cabbage Maggot studies.**—Experiments on control of cabbage maggot were conducted at Glenville, N. C., at an altitude of about 3500 feet on cabbage seedlings, set cabbage plants and radishes.

CABBAGE SEEDLINGS PLANTED APRIL 15, 1935—PERCENTAGE INJURED PLANTS

Weekly Applications				Corrosive Sublimate 1 part to 1,280	Corrosive Sublimate 1 part to 1,600	Calomel Dust 5 Percent in Tale
1st	2nd	3rd	4th Week			
1				33.	57.	67.
1	2			23.	33.	57.
1	2	3		0.	1.5	47.
1	2	3	4	0.	0.	0.
	2			40.	27.	61.
	2	3		5.	2.	2.8
	2	3	4	0.	0.	1.5
		3		11.	4.	3.7
		3	4	7.	1.5	1.6
			4	25.	24.	10.
Average adjacent checks				57.	52.	67.



In the experiment with set cabbage plants the plants could not be pulled for examination.

#### PERCENTAGE OF PLANTS DEAD OR REPLACED ON ACCOUNT OF INJURY

Treatment	Corrosive Sublimate 1 part to 1,280					Corrosive Sublimate 1 part to 1,600					5 Percent					Check
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	
Total weekly applications..	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	
Percent injured.....	32	10	5	7	9	27	10	25	12	10	45	25	5	0	13	42

In the experiment with radishes the infestation was greater, due partly to the fact that the presence of a single maggot is more readily detected than on a cabbage plant. Many of the check plants were totally destroyed and could not be counted. The average of injured plants remaining in all checks was 86%. The percentage of treated plants injured by maggots is given only for those having three weekly treatments, as follows:

Corrosive sublimate	1 to 1280	26 % and 28 %
Corrosive sublimate	1 to 1600	8 % and 16 %
Calomel in talc	5 % dust	31 % and 42 %

The influence of planting time on maggot infestation is shown by a cabbage seedling bed about half a mile from the experimental bed, planted April 25 and germinating at least two weeks later than the experimental bed. This bed had no more than 3% of the plants with maggot injury on untreated portions at transplanting time on June 3. (B. B. Fulton)

## TOMATO STUDIES

**A study of tomato breeding for bacterial wilt resistance.**—This project was begun with emphasis on bacterial wilt control. It has been definitely shown in our field plots that certain varieties, notably the Louisiana Pink variety, are somewhat resistant to bacterial wilt, while others, such as Scarlet Dawn, are quite susceptible. Numerous field selections made during the past two years have not been consistent in their resistance. Crosses were made between Louisiana Pink and Marglobe, but up to the present time no definite indications are shown that the resistance of the Louisiana Pink has been passed on to the resulting progenies. Further testing of these progenies is in progress. (Robt. Schmidt)

**A study of tomato varietal adaptability.**—Twenty-five varieties of tomatoes were on test in 1937 and twenty-four varieties in 1938, but no new varieties were outstanding. (Robt. Schmidt)

## LETTUCE STUDIES

**Lettuce Breeding.**—The objective of this project is to develop strains and varieties of lettuce which are improvements over present varieties, better adapted to North Carolina soil and climatic conditions, and resistant to disease. The field work is being done at Wilmington and Raleigh, moving the selected plants to the greenhouse at Raleigh for seed

production. Selections are being made from a number of segregating hybrid lines. Several promising selections have been made in the Wilmington section and a variety has been developed which is giving very good results under Piedmont conditions. (Robt. Schmidt)

## PICKLE STUDIES

**Studies of the pickle worm and its control.**—The first pickle worm of the season on summer squash at Raleigh was found on July 12, but by July 15 nearly half of the squash had small worms. Dusting experiments on summer squash were started on July 15 and applied at weekly intervals as long as the plants continued to bear. The materials used and their average rank in control for the season were as follows:

Plot	Treatment	Average Rank in Control
1	Lead arsenate 20% in tale.....	5
2	Lead arsenate 33% in tale.....	4
3	Lead arsenate 100% whole plant.....	2
4	Lead arsenate 100% on growing tips.....	3
5	Synthetic cryolite 20% in tale.....	7
6	Synthetic cryolite 100%.....	1
7	Cube 5% 4 parts, sulphur 5 pts., walnut flour pts. 11.....	6
8	Check.....	8

The plots ceased bearing, due to destruction of growing tips by pickle worm in the following order: No. 8, Aug. 6; No. 7, Aug. 11; Nos. 1, 2, 5, Aug. 18; Nos. 3, 4, Aug. 24; No. 6, Sept. 7. (B. B. Fulton)

**A study of methods for preserving cucumber pickle.**—Studies were carried on at commercial plants as previously reported. In 1937 the cooperators provided ten small vats allowing complete control over approximately one thousand bushels of experimental material. The experiments included a study of the influence of the salting program on the curing and keeping of salt stock; and an elaborate dill salting program involving sixteen different curing schedules.

Salt stock records taken at the end of the curing period indicated that, with one exception, the quality of the salt stock produced according to the different salting programs was from satisfactory to excellent. An evaluation of this salt stock after a storage period of eight months under commercial conditions indicated that, with the above mentioned exception, all material exhibited only slight deterioration in quality as a result of such storage. Samples of the salt stock have been made into pickles (processed) and are under further observation for quality and keeping properties.

Results of the dill experiments were not wholly satisfactory, although nearly all schedules produced products which were commercially usable. Further studies are under way in this connection.

A large number of samples of fresh cucumbers and of cucumbers after various periods of salting treatments have been obtained. Samples were preserved by freezing, by drying, and in alcohol in order to determine

suitable methods of preservation of fresh or salted cucumbers for chemical analyses. (Ivan D. Jones, Otto Veerhoff, Coop. M. K. Veldhuis, J. L. Etchells)

## ROSE STUDIES

**A study of roses under greenhouse conditions.**—Seven varieties of roses were included in this test. The following is a list of varieties tested according to production: William Ekas, Mrs. Frank Schramm (pink), Happy Days (pink), Mur-ray (pink), Lestra Hibberd (cream), Signora (Talisman novelty) Chieftan (red).

All the varieties in the test made satisfactory growth and seemed to be reasonably resistant to disease, with the exception of Chieftan, which was especially susceptible to powdery mildew. (G. O. Randall, J. G. Weaver)

**A study of roses under free conditions.**—The following new varieties were added to the rose test garden in the spring of 1938:

Alice Harding (yellow), Brozier, (brilliant carmine), Eclipse (yellow), Golden Maine (bright yellow), Miss America (dainty pink), Mme. Henri Guillot (salmon pink), Radio (yellow tipped with pink and splashed red), Rome Glory (crimson), and White Briarcliff (white).

These will be grown at least three years before a final report is made on their adaptability. (G. O. Randall, J. G. Weaver)

## BULB STUDIES

**Studies on the fertilization of bulbs.**—The data collected on bulb fertilization for the past two years on the original experiment show no significant differences in the treatments except that the one-thousand-pounds-per-acre rate of application gave just as high yields as the two thousand pound rate; and that boron had some beneficial effect on flower development in the case of narcissii, which was the kind of bulb used throughout the experiment. The original experiment is being continued for one more year before final conclusions are drawn.

Data for only one year have been secured from the time and placement experiment. For that reason no conclusive results have been obtained, although interesting differences have been shown. (G. O. Randall, J. G. Weaver, S. L. Emsweller, D. Victor Lumsden)

## CARNATION STUDIES

**A study of carnation varieties.**—During the past several years new varieties of carnations have been tested in comparison with older standard varieties. This test has been continued during the past year and includes twenty-four named varieties and seedlings. Of the twenty-four tested, the following five produced the highest average yields:

Vivian (pink), Puritan (white), Peter Fisher (light pink), Chief kokomo (variegated yellow and pink), Satellite (red).

Of the unnamed North Carolina seedlings, N. C. 30, 1-35-46, N. C. 38 and 18-35-28, N. C. 30 outyielded the others tested, and N. C. 38 ranked fourth in production of flowers. The variety Antarctic, while one of the

highest yielding of the whites, was especially susceptible to rust. (G. O. Randall, J. G. Weaver)

## POULTRY STUDIES

**A study of the effects on production and cost of lighting laying pullets.**  
—This study was started October 1, 1936, with two commercial units of S. C. White Leghorn pullets, given representative commercial poultry plant management. Morning lights only were used on the test pen. In 1936-37 a 12-hour day was used, and in 1937-38 a 14-hour day. In the present year, 1938-39, a 16-hour day is being tested out. No culling was done. The results are given in the table below.

EFFECTS OF LIGHTING ON COST AND PRODUCTION

Year	No. Birds		Eggs Per Bird		Grain Per Bird		Mash Per Bird		Died		Feed Cost Per Doz. Eggs		Duration of Test	KWH Used in Test Pen
	Cont.	Test	Cont.	Test	Cont.	Test	Cont.	Test	Cont.	Test	Cont.	Test		
1936-37-----	168	164	62.2	63.0	18.6	19.0	16.3	17.0	23	22	.166	.169	5	69
1937-38-----	163	169	93.0	95.0	40.3	40.3	41.7	41.8	20	15	.116	.109	7	71

(R. S. Dearstyne and Hubert Smith)

### The effects of feeding yeast fermented mash to laying pullets.—

1. Weighted averages of three years tests with S. C. White Leghorns (Test I) in which the basal diet was common to both control and test pens and in which the control pen was fed an equivalent amount of wet mash per bird to yeast fermented mash in the test pen, the birds in the control pen produced 195 eggs per bird in the test pen. The birds in the control pen consumed 41.9 lbs. of grain and 39.9 lbs. of mash per bird, while the birds in the test pen consumed 42.9 lbs. of grain and 41.6 lbs. of mash per bird. Differences in mortality rate were not significant. The test birds came into heavy production more rapidly than the control birds. The test was genetically controlled to the extent that sister for sister was used in the respective pens. The fact that the basal diet was common and that supplementary feeding was relatively equal from a quantity standpoint indicates to the writers that the feeding of yeast fermented mash stimulated appetite and led to higher feed consumptions and to higher egg production.

2. Weighted averages of three years tests (Test II) with S. C. Rhode Island Red pullets in which the basal diet was common to both control and test pens and in which the test pen received a supplementary feeding of yeast fermented mash, show the birds in the control pen producing 140 eggs per bird and the birds in the test pen producing 150 eggs per bird. The birds in the control pen consumed 48.6 lbs. of grain and 41.7 lbs. of mash per bird, while the birds in the test pen consumed 48.7 lbs. of grain and 46.6 lbs. of mash per bird. Mortality differences were not significant.

The test birds came into production earlier than the control birds and maintained higher production throughout the test.

3. Weighted averages are presented of three years of study (Test III) on the effect of supplementary feeding of: (1) wet mash, (2) wet mash with 1% killed yeast, (3) wet mash with 1% live yeast, and (4) yeast fermented mash. The production and feed consumption per bird during the period of test of these pens was: (1) 169 eggs with 48.5 lbs. grain and 39.7 lbs. of mash per bird; (2) 168 eggs with 48.7 lbs. grain and 37.0 lbs. mash per bird; (3) 176 eggs with 50.8 lbs. grain and 40.3 lbs. mash per bird, and (4) 179 eggs with 49.2 lbs. grain and 40.7 lbs. mash per bird. In these tests the mortality rate in the yeast fermented mash pen was relatively lower than in the other pens. The 8 and 11 eggs difference in performance of pens 3 and 4 as compared with pen 2 indicates to the writers that the enzymes of the live yeast probably were the causative factors of higher production as pen 2 received the same nutritive equivalent in the killed yeast supplement as pens 3 and 4 received from the live yeast supplement. The margin of performance—10 eggs of pen 4 over pen 1 in this test, is similar to that of Test II, despite the fact that pen 1 in Test III received an equivalent supplement of wet mash to the yeast fermented mash in pen 4. This test, likewise confirms the tendencies of Test I, although a 10 egg margin in favor of yeast fermented mash is secured in pen 4 as compared to 5 eggs in Test I. It is of interest to note that the performance of pen 3 is 7 eggs higher than pen 1, and 3 eggs less than pen 4, this indicating a value of live yeast in the mash though to a less degree than yeast fermented mash.

4. Tabular presentation is made of egg weights of sisters completing records in Test I. During three years 18,287 eggs were weighed from the control pen, and 18,335 from the test pen. The average weight of eggs from the control pen was 1 27858/32000 ounces and from the test pen was 1 27881/32000 ounces. The difference in egg size as shown in these studies is not significant. Forty-seven birds in the control pen laid eggs of a larger average size than their sisters in the test pen; 51 birds in the test pen laid eggs of a larger average size than their sisters in the control pen, and 11 pairs of sisters laid eggs of an equal average size. (R. S. Dearstyne and C. O. Bollinger)

**A study of the effect on total egg production and on hatchability of eggs produced by replacing certain animal protein concentrates in the N. C. State laying mash with peanut meal.**—Project started in November, 1937, with 46 Rhode Island Red pullets per pen; increased to 60 pullets per pen in December. Diets as to protein concentrates as follows:

Pen 1 (control)—6½ lbs. fish meal; 6½ lbs. meat scrap; 7 lbs. dried buttermilk.

Pen 2—11 lbs. meat scrap; 6 lbs. peanut meal; 2 lbs. dried buttermilk.

Pen 3—11 lbs. fish meal; 6 lbs. peanut meal; 3 lbs. dried buttermilk.

Pen 4—6 lbs. fish meal; 7 lbs. peanut meal; 6 lbs. meat scrap.

## TABULAR SUMMARY OF PEANUT MEAL TESTS

PRODUCTION STUDIES—NOVEMBER, 1937-AUGUST, 1938

	Average Number Birds	Total Eggs	Average Eggs Per Bird	Pounds Feed Per Bird		Feed Cost		Pounds Grain and Mash to Produce a Dozen Eggs	Died
				Grain	Mash	Per Bird	Per Doz. Eggs		
1	55	6,906	126	40	35	1.66	.159	7.2	7
2	55	7,918	144	40	35	1.61	.134	6.2	7
3	56	7,884	141	40	39	1.67	.142	6.7	8
4	55	7,747	141	41	36	1.57	.134	6.5	11

## MORTALITY TO 10 WEEKS OF AGE

Pen and Diet No.	Number Chicks	Died First 10 Weeks	Per Cent
1.....	259	26	10.4
2.....	212	34	16.0
3.....	272	33	12.1
4.....	234	27	11.5

## HATCHABILITY STUDIES

Pen and Diet No.	Eggs Set	Fertile		Dead Germs			No. Chicks	Percent Hatch Fertile Eggs	Percent Hatch All Eggs
		No.	Percent	18th Day	22nd Day	Percent			
1	903	74	92	37	81	14	711	86	79
2	882	138	84	29	70	13	645	87	73
3	920	95	90	29	75	13	721	87	78
4	909	118	87	31	64	12	695	88	76

(R. S. Dearstyne and C. O. Bollinger)

**A study of the hematology of the fowl.**—Hematological studies have been made on 13 birds comprising 26 separate studies, including numerical, differential counts, and hemoglobin estimations. Supravital technic was used in determining the differential count and morphological changes in the cells. Wright-Giemsa stained smears were made and held as a permanent record of the blood picture.

Nine studies have been made on six male birds from a family of Barred Rocks showing a type of fowl paralysis apparently inherited. These birds are connected with Bankhead-Jones project, "A study of the influence of



linebreeding and controlled mating on the livability of poultry." These studies are to be continued throughout the period of the project.

Eight studies were made on three paralyzed birds received by the laboratory for diagnosis. This study covered a period from August 1 to October 19. Antemortem and postmortem studies were made. Histological studies are in process.

Six studies from a single case of myeloid leukosis were made during the period from May 7 to August 9, 1938. Antemortem studies and post-mortem observations were made.

Two studies were made on a bird with a pectoral tumor weighing over 5 pounds.

One study was made on the blood of guinea hen received for diagnosis.

One study was made on the blood of a hen showing sex reversion. The blood of this bird is to be studied further. Histological studies are also to be made.

#### SUMMARY

Apparently inherited paralysis	6 birds	9 studies
Paralysis	3 birds	8 studies
Myeloid leukosis	1 bird	6 studies
Tumorous bird	1 bird	2 studies
Guinea hen	1 bird	1 study
Sex reversion	1 bird	1 study

(F. W. Cook)

#### Studies on Paratyphoid Infection in Pigeons

**Results of Study I.**—In routine agglutination tests on 55 birds in group II, the blood sera from a large majority of the birds reacted positively with paratyphoid antigen. On autopsy paratyphoid organisms were recovered from a large percent of the birds which were recorded as positive in the agglutination studies. In a few instances paratyphoid organisms were recovered from birds whose sera were repeatedly negative in the tube agglutination test applied. The recovery of the pathogen from so-called "negative" birds is of particular interest since it casts doubt on the value of routine agglutination tests in the detection of chronic carriers of pigeon paratyphoid. Since paratyphoid organisms were recovered from so-called "negative" birds and since this phase of our study is of particular importance, a new lot of adult pigeons (Group III) was subjected to routine agglutination and bacteriological tests. Results of the study on the Group III birds are presented in "results of Study III."

**Results of Study II.**—Paratyphoid organisms were recovered very frequently from the mouth fluids, feces, and blood of the squabs examined. The frequency of recovery of the pathogen indicates that the squabs were in the acute or in the subacute stage of the disease during the test period. On autopsy several weeks after the above tests were completed, paratyphoid organisms were recovered from the internal organs of a large majority of the squabs which were positive to routine agglutination tests. Information on the dissemination of pigeon paratyphoid is brought out by this study.

**Results of Study III.**—(Group III Birds)—A third group of pigeons consisting of 28 adult birds was subjected to routine tube agglutination tests. After the completion of several tests the birds were autopsied and the

internal organs were examined for gross lesions and examined bacteriologically. Paratyphoid organisms were recovered from one or more of the internal organs of a large majority of the birds which were found to be positive to agglutination tests and also from a number of birds which were negative to the agglutination test applied. The full significance of the recovery of the pathogen from birds that were negative to agglutination tests has not been determined. (H. C. Gauger)

**Studies of paratyphoid infection in pigeons.**—Forty recoveries from eleven pigeons were studied to determine their cultural, morphological, biochemical and seriological properties. Known type strains were included. Three strains were discarded as they proved to be slow lactose fermenters and were otherwise found not to be related to the endemic strains.

Extract agar plates (pH 7.2-4) were used to study colonial morphology. The type of growth in extract broth (pH 7.2-4) containing 0.5 percent salt was observed at 24 and at 48 hours. The Pampana and the thermo-agglutination tests were also applied to determine R and S properties. Microscopic morphology was observed by the preparation of Gram stains. Motility was determined by growth in semi-solid agar shorts.

Biochemical studies included reactions in the following substrates: Dextrose, lactose, maltose, mannite, sucrose, raffinose, trehalose, arabinose, zylose, rhamnose, inositol. The reactions were typical for *Sal. typhimurium* save in maltose, where typically acid but not gas was produced. The tartrate test of Jordan and Harman was used to differentiate these strains from paratyphoid B. The "Bitter" test in which rhamnose, maltose and Zylose were used was carried out for epidemiological significance. All strains were indol negative and  $H_2S$  positive.

Serological tests have included agglutination and agglutinin adsorption tests. In straight agglutination tests all strains agglutinated to titer save one. No strain was agglutinated by type antisera containing somatic factors IV and V, after the IV factor had been adsorbed out. A limited number of reciprocal agglutinin adsorption tests were completed. Thus the isolations from this endemic are indicated as being *Sal. typhimurium* var. Binns (Edwards—*The Journal of Hygiene*, Vol. 36, p. 348). An investigation of the flagella antigens has not been completed. (H. C. Gauger and R. E. Greaves)

**Investigation of Septicemic Diseases Among Fowls in North Carolina.** A search for a "virulence" antigen in *Sal. pullorum* and *Sal. gallinarum*.—It has not been possible to demonstrate in *Sal. pullorum* or *Sal. gallinarum* the presence of a "Vi" type antigen following the technic commended by the work of Felix and Pitt (1936).

This endemic conduct of these strains most certainly indicates that there is a virulence factor to be found in some strains that is absent in others. Accordingly a cue was taken from some observations of Gay and Claypole (1913) regarding the different antigenic responses of typhosus when grown on extract vs. blood agar. These observations have never been explained and in the light of the work of Felix and Pitt it seems possible that the explanation is to be found in the production of a "Vi" antigen in typhosus strains grown on blood agar.

Whereas immunization of rabbits by the injection of live organisms is possible when these strains are grown for any length of time on extract agar, they have proven extremely virulent when isolated and grown on blood agar. Rabbits previously immunized in the accepted manner are usually killed by the injection of moderate or even minute doses of live organisms grown on blood agar. However, it has been possible to prepare duplicate lots of intisera and it is hoped to complete adsorption tests in the near future. (R. E. Greaves)

**Investigation of septicemic diseases among fowls in North Carolina. Studies on normal agglutinins.**—Observations on the presence of normal agglutinins for *Sal. pullorum* and *Sal. gallinarum* in fowls have been accumulated and recorded for some time. Other members of the colon-typhoid intermediate group and organisms from other bacterial groups have been included in these studies.

To accomplish this end numerous bacterial strains have been secured and examined, those being selected for use that appeared to be "smooth" or practically so, and that were stable in alcoholic suspensions as it was felt an investigation of the presence in birds of somatic agglutinins was all we could undertake. The following bacterial strains were selected: *Salmonellas paratyphoid A* (Topley), *typhi-murium* (IV-V type and IV type), *cholera suis kunzendorf*, *newport*, *pullorum*, *gallinarum*, *anatum C-5*, *anatum C-1*, *aberdeen smith* and *poona*; these strains accounting for practically all of the known somatic antigens of the typhoid-paratyphoid group. In addition the following bacterial strains were included: *P. avicidia*, *Br. abortus*, *B. dysentery Shiga*, *B. dysentery Y*, *Mucosus capsulatis*, *B. coli communior* (fecal), *B. coli communior* (chick liver), *B. pyocanens*, *B. protens X-19*, and *Aerobactor aerogenes*. It is believed that this list of organisms gives the widest variety and most complete coverage of any reported on.

The limited data on hand as a result of tests in which the above organisms have been used are interesting in that they show the mature fowl to have agglutinins for all of the *Salmonellas* in a 1-25 serum dilution in most cases. This was true also of *Br. abortus*, *B. dysentery Y*, *B. coli communior* (fecal), *B. protens X-19*, and *A. aerogenes*. *P. avicidia*, *B. dysentery Shiga*, *M. capsulatis*, *B. coli communior* (chick) and *B. pyocanens* were not agglutinated by fowl sera in a 1-25 dilution and seldom showed traces in a 1-10 dilution. It will be noted that *P. avicidia* and *B. dysentery Shiga* are not known to be pathogens present in North Carolina, septicemic *B. coli* infection is rare and that the others that gave negative results, though present, rarely produce disease. It is also interesting that four strains used of known recent isolation gave a decidedly higher titer, often to 200 and 400, than did type stock cultures. *B. dysentery Y* and *S. anatum C-1* also reacted in high titres.

To investigate the possibility that these so-called normal agglutinins might be an inherited factor, appropriate matings were made and progeny raised. The incidence of normal agglutinins for the various antigens listed above in the parents and progeny is to be investigated. (R. E. Greaves)

**Study of a family of Barred Rocks showing a type of fowl paralysis apparently inherited.**—The surviving members of the family of Barred Rocks from which during 1938 there were eight deaths from a paralytic-like

condition, have been obtained and are being studied at the Central Plant. The original sire and dam, with offspring consisting of 13 pullets and 15 cockerels, are available for crosses. Matings to test as many of these individuals as possible for the transmission of this condition have been planned, and several hatches of chicks will be made early in 1939.

Further procedure will follow the plans as outlined in the project. (C. H. Bostian and R. S. Dearstyne)

**A study of the influence of line breeding and controlled mating on the livability of poultry.** (a) A study of families derived from line breeding in relation to livability. (b) The influence of mating from superior families on livability.—Mortality of chicks: Studies on the livability of chicks have now been completed for two hatching seasons. In 1937, 1,732 chicks were obtained from six pen matings. Reference may be made to the annual report of 1937 for a description of these six matings and their objectives. For the chicks weights were taken at hatching and at thirty day intervals and records made of lost bands and mortality. Through ninety days of age, mortality may be summarized as follows:

TABLE I.—MORTALITY OF CHICKS BY PENS—1937.

Pens	Chicks	Lost	Died	Percent Lost	Percent Died	Percent Lost and Dead
1.....	179	19	9	10.6	5.0	15.6
2.....	278	23	19	8.3	7.0	15.3
3.....	226	17	11	7.1	5.0	12.1
4.....	404	23	14	5.5	3.5	9.0
5.....	290	30	12	10.4	4.1	14.5
6.....	355	22	20	6.2	5.6	11.8
Total.....	1,732	134	85	7.7	4.9	12.6

TABLE II.—MORTALITY OF CHICKS FOR FAMILIES OF TEN OR MORE—1937.

Per cent of Mortality.....	00	0-9	10-19	20-29
Family Incidences.....	26	30	7	1

During the hatching season of 1938, 1,580 chicks were obtained from six pen matings which, in general, were similar to those of 1937, but in some cases with selection toward improving livability. Mortality for these chicks is summarized in Tables III and IV.

Total mortality for the chicks of 1937 and 1938 was 4.9 and 9.4 percent, respectively. Consideration of the causes of mortality reveals the main reason for this difference between the two groups of chickens. During 1937, 13 deaths resulted from coccidiosis, 16 more were accidental, 2 were cripples, and 54 were considered due to unknown causes. During 1938 an epidemic of coccidiosis involved the chicks of two hatches, and accounted for 63 deaths out of 148; 78 were assigned to unknown causes, 6 were cripples, and 1 was accidental. But for the increased incidence of coccidiosis, mortality was about the same for the two years.

TABLE III.—MORTALITY OF CHICKS BY PENS—1938.

Pens	Chicks	Lost	Died	Percent Lost	Percent Died	Percent Lost and Dead
1.....	214	5	23	2.3	10.7	13.0
2.....	313	8	28	2.5	8.9	11.4
3.....	233	4	19	1.7	8.1	9.8
4.....	305	2	21	0.6	6.8	7.4
5.....	234	10	46	4.2	19.6	13.8
6.....	281	4	11	1.4	3.9	5.3
Total.....	1,580	33	148	2.1	9.4	11.5

TABLE IV.—MORTALITY OF CHICKS FOR FAMILIES OF TEN OR MORE—1938.

Percent of Mortality.....	00	0.9	10-19	20-29	30-39	40-49
Family Incidences.....	18	20	22	8	1	1

**Mortality of pullets.**—When the chicks of 1937 became three months of age most of the cockerels were discarded, but all pullets were retained and legbanded. Subsequently, they were weighed at 30-day intervals until reaching maturity. All birds surviving are being kept until the completion of one laying year, to obtain records of production and egg weights which will be correlated with livability, days to sexual maturity, body weights, and in other ways. An attempt has been made to determine the cause of all deaths, usually by autopsy. Summaries are presented showing mortality through 365 days, and through 500 days. It will be observed that of 768 pullets, 101 died by the end of 365 days of age, and that 185 were dead by the end of 500 days. Table V shows mortality by pens, with the percentages of survival ranging from 67 to 80. In Table VI families containing six or more pullets are arranged according to the percentages of mortality. Six families had no deaths at the end of 500 days.

In Table VII the causes of mortality are tabulated. Only the conditions of vent gleet and respiratory infections are known to be caused by specific

TABLE V.—MORTALITY OF PULLETS BY PENS—1937.

Pen	Pullets Banded	Survivors			
		365 Days	Percent	500 Days	Percent
1.....	73	60	82	50	67
2.....	118	103	87	94	80
3.....	98	86	88	77	79
4.....	191	172	90	149	78
5.....	133	114	86	96	72
6.....	155	132	85	117	75
Total.....	768	667	87	583	76

or causal organisms, and since these two conditions account for only fourteen percent of the total mortality, it is seen that the greater proportion is due to causes for which the only known remedy is breeding.

For the hatching season of 1939, four of the pen matings have been planned with the aim of improving livability, and the crosses involve several degrees of inbreeding and outbreeding. One of the pen matings has the parents selected from families having high mortality of chicks, and the other from families having high mortality of both chicks and pullets.

TABLE VI.—MORTALITY OF PULLETS BY FAMILIES AT END OF 500 DAYS. INCLUDES FAMILIES CONTAINING AT LEAST SIX PULLETS

Per Cent of Mortality.....	Zero	0-9	10-19	20-29	30-39	40-49	50-59
Number of Families.....	6	3	15	14	9	4	4

TABLE VII.—CAUSES OF PULLET MORTALITY.

Condition	Incidence by Periods		Both	Per Cent of Total
	90-365 Days	365-300 Days		
Neoplasms.....	9	2	11	.6
Prolapsis.....	32	15	47	26
Reproductive system.....	9	11	20	11
Heat.....	0	15	15	.8
Miscellaneous.....	3	5	8	4
Unknown.....	22	36	58	31
Vent gleet.....	11	0	11	6
Respiratory.....	15	0	15	8
Total infections.....	101	84	185	100

(C. H. Bostian and R. S. Dearstyne)

**Identification of tapeworms infesting fowl of North Carolina and their relationship to leg weakness and blindness of fowl.**—The life-histories of the tapeworms, *Raillietina tetragona* and *Raillietina echinobothrida*, are incompletely known. Two species of ants, *Tetramorium caespitum* and *Pheidole vinelandica*, are known to serve as intermediate hosts. It has been definitely established by others that chickens become infected with these tapeworms as a result of eating ants which contain the cysticeroids of these two cestodes. The question remains as to how the ants become infected with larval cestodes. An attempt to answer this question is now in effect.

Six chickens parasitized with *Raillietina tetragona* were obtained on September 22, 1938, and the proglottids secured are being fed to various species of ants. Ants eat the proglottids readily but as yet no cysticeroids have been isolated from experimentally fed ants. It is possible that ants become infected during the larval stage when they are fed regurgitated food by the worker ants.

Twenty-five chicks were obtained on November 3, 1938, and are being raised under parasite free conditions in the laboratory.



In addition to the above experimental work forty-six chickens have been examined since the June report. Of these 23 were infected with tapeworms as follows: 15 harbored *Raillietina tetragona*, 6 *Hymenolepis carioca*, 5 *Raillietina cesticillus* (three cases were mixed infections). These make a total of 184 chickens examined to date, with 95 harboring cestodes.

The following is a list of the species of tapeworm found and the number of hosts infected:

<i>Raillietina tetragona</i> .....	63
<i>Hymenolepis carioca</i> .....	23
<i>Raillietina cesticillus</i> .....	11
<i>Raillietina echinobothrida</i> .....	4
<i>Choanotaenia infundibulum</i> .....	1

The following cases were mixed infections:

<i>R. tetragona</i> and <i>H. carioca</i> .....	6
<i>R. tetragona</i> and <i>R. cesticillus</i> .....	3
<i>R. echinobothrida</i> and <i>H. carioca</i> .....	2
<i>R. tetragona</i> and <i>R. echinobothrida</i> .....	1
<i>R. cesticillus</i> and <i>H. carioca</i> .....	1

Approximately 53 percent of the chickens examined were parasitized with tapeworms. Of these 69 percent harbored *Raillietina tetragona* or *R. echinobothrida*, indicating that these two tapeworms are most prevalent in this state. (R. Harkema and H. C. Gauger)

## CATTLE STUDIES

**Vitamin "A" studies with cottonseed meal fed to beef cattle.**—The report given last year was complete for all the cattle except one heifer on 30 percent soybean hay. She had calved a heifer calf on July 15, 1936, and she and her nursing calf had been continued on Ration No. 4 (26 % each of cottonseed meal and white corn meal, 17 % cottonseed hulls, 30 % ground soybean hay, and 1 % of a mineral mixture). Both apparently developed normally on this ration. At calving the heifer weighed 525 pounds, and her calf 53 pounds. At weaning on December 15, 1936, the calf weighed 220 pounds, and its mother 670 pounds. This heifer was slaughtered on April 13, 1937, at a weight of 765 pounds, and her calf was slaughtered on September 27, at a weight of 595 pounds.

As was reported last year, both of the heifers on the 26 % yellow corn ration, and one of the two on the 20 % alfalfa hay ration "broke" (went off feed, became stiff, etc.) but recovered when changed to Ration 4. Ration 3, containing 20 % soybean hay, was also adequate for growth and fattening.

The results of these investigations are now being prepared in bulletin form. (J. O. Halverson, Earl H. Hostetler, and J. E. Foster)

**A study of different roughage for beef cattle.**—The plan of work, together with progressive reports of this project, were given in the last two reports.

From April 20 to November 2 the yearlings grazed on lespedeza pasture and made an average daily gain of 1.2 pounds. Their average weight at the close of the grazing period was 755 pounds.

Eighteen steer and spayed heifer yearlings were paired, grouped, graded, and started on the roughage feeding trials on November 2, 1937. The feeder grades at this time averaged Good, with one Medium and four Choice.

Whenever an individual in Group I (which received 10 pounds of shelled corn per head daily and lespedeza hay ad libitum) reached 1000 pounds in weight it and the one paired with it in Group II (which received only lespedeza hay) were slaughtered. Slaughter and carcass grades were also taken at this time.

Pairs of cattle were slaughtered on December 21, February 7, 9 and 17, April 20, May 9, 13 and 31, and on June 13.

The average feed consumed for 100 pounds gain from November 2, 1937, to June 13, 1938, is shown below:

Feed	Group I	Group II
Lespedeza hay.....	705.38	2,195.28
Shelled corn.....	620.14	
Feed cost*.....	\$ 16.35	\$ 21.95

\*Lespedeza hay \$20.00 per ton

Shelled corn .84 per bushel.

The average daily gains for Group I were 1.60 pounds, and for Group II .87 pound.

When Groups I and II were started on feed on November 2, five similar but unspayed heifers, which had been grazing with the yearlings composing these groups, were added to the breeding herd. They were grazed on winter pasture (old permanent pasture, rye grass, and barley) and fed cottonseed hulls and some lespedeza hay until March 22. After this date feeding was discontinued. During the same period of 196 days from November 2 to May 17, these five heifers made an average daily gain of 1 pound. Since March 22 on pasture alone they made an average daily gain of 2.5 pounds.

Average grades of the 9 pairs of cattle slaughtered from December 21 to June 13, are shown below.

	Group I	Group II
Average feeder grade.....	16 (Middle Good)	14 (High Good)
Average slaughter grade.....	14 (High Good)	18 (Low Good)
Average carcass grade.....	14 (High Good)	18 (Low Good)

The cow herd calved again in the spring of 1937, and the calves ran with their mothers on pasture at the Animal Husbandry Farm, Raleigh, until June 8. By this time the pasture had become so dry, due to an early drouth, that the cows and their calves were moved to reed pasture on the State Forest in Onslow County. At the time they were moved the 28 cows averaged 954 pounds and their 18 calves 222 pounds.

These calves were weaned and returned to Raleigh on November 11, at which time they averaged 318 pounds. Four similar steer calves from

Wenona, averaging 416 pounds, were weaned and added to this group on November 18. From November 11 to March 23 when the weather would permit, they grazed on Italian Rye grass and crimson clover. In addition, they received 2 pounds of shelled corn per head daily, and all the lespedeza they would clean up. Very little hay was consumed though when the calves were on pasture. The heifers were spayed on February 15. On March 22, at which time feeding was discontinued, they averaged 471 pounds, showing an average daily gain of slightly over 1 pound since weaning. One heifer was found dead on April 8. The other 21 head averaged 632 pounds at the last weighing on May 17. Since March 22 they had made the remarkably large average daily gain per head of 2.8 pounds on crimson clover and rye grass pasture alone.

Eight of the cows were returned on November 11 with the calves and were wintered on cottonseed hulls, lespedeza hay, cottonseed meal, and pasture. The rest of the cow herd was wintered in Onslow County on reeds and cottonseed cake. Twenty-six calves were born from these cows in the spring of 1938, and ran with their dams on barley, oats, rye grass and crimson clover pasture at the Animal Husbandry Farm, Raleigh, N. C., until June 28, when they were turned on lespedeza pasture. On June 14 the nursing cows averaged 841 pounds, and the calves 202 pounds. Fifteen two-year old Hereford heifers were added to the herd in the spring of 1938, and breeding was started the last week in April. (Earl H. Hostetler and J. E. Foster)

**Comparative study of fattening first cross versus second cross Hereford yearling steers.**—This test was conducted at the Blackland Station from November 19, 1937, to April 13, 1938, covering a period of 145 days. It included 7 first cross steers and 4 second cross steers. All of these yearlings were sired by the same purebred Hereford bull. The first crosses were out of Native Eastern Carolina cows, and the second crosses were out of first cross cows, which in turn were out of the same or similar Native cows and by a purebred Hereford bull.

The two groups were fed separately a ration of 2 pounds of cotton seed meal and 5 pounds of soybean hay per head daily, and a full feed of shelled corn and corn stover.

The first cross yearlings averaged 610 pounds when started on feed and made an average daily gain of 2.1 pounds. The second cross yearlings averaged 683 pounds when started on feed and made an average daily gain of 2.3 pounds.

To produce 100 pounds gain the second cross steers consumed 696 pounds of concentrates and 551 pounds of roughage. This was 20 pounds less concentrates and 1 pound less roughage than the first cross steers consumed. Therefore, there was very little difference in the cost of the gains in the two groups.

As feeder and slaughter cattle the second cross yearling steers graded about one-third grade higher than the first cross ones. However, in the carcass both groups graded the same (Top Good) and sold for 15 cents per pound in Baltimore.

A repetition of this trial is to be started in November, 1938. (Earl H. Hostetler and J. E. Foster)

**A study of dairy cattle as a supplementary enterprise to cotton farming in the Piedmont section of North Carolina.**—This study was started in 1928 for the purpose of showing the effect of a systematic crop rotation on crop yields and the value of a dairy enterprise as a supplementary income to cotton farming. It is a joint project between the Dairy Husbandry, Agronomy, and Agricultural Economics departments. The Department of Agricultural Economics posts the monthly labor and cost data, and at the close of each year prepares a summary statement showing the cost of each crop produced and the cost of producing milk. A summary of the operations for 1937 has been prepared. (R. E. L. Greene and C. D. Grinnells)

**Soybean hay, alfalfa hay and yellow corn as sources of Vitamin A for growing cattle fed cottonseed meal rations.**—Yellow corn to the extent of 25 or 26 percent in the entire ration proved to be inadequate for growing cattle; likewise, 20 and 30 percent of the locally grown alfalfa hay, No. 3. Twenty and 30 percent soybean hay was adequate, also for one animal in reproduction and lactation. The amount of International units of vitamin A per kilogram of body weight per day was measured. Amounts of 11 to 33 International units of vitamin A per kilogram of body weight per day from yellow corn, 8.9 percent alfalfa meal or alfalfa hay was inadequate for growing cattle; 59 or above International units of A from 20 or 30 percent of soybean hay proved to be adequate for growing cattle. (J. O. Halverson, Earl H. Hostetler, F. W. Sherwood and J. E. Foster)

**Lespedeza as supplementary pasture for dairy cattle.**—Fairly satisfactory stands of lespedeza were obtained on all plats with the exception of the one seeded to Kobe. Weeds were particularly bad on this plat.

Tennessee 76 and common lespedeza had much better stands and fewer weeds during the 1937 growing season. Discing, fertilizing and reseeding produced decided changes in these relationships. The Korean plat had a better stand, produced more growth and contained fewer weeds than any of the other plats during the 1938 growing season.

Because of the density of growth, it was not possible to make relative density readings in the lespedeza plats with the point quadrat. The soil treatments showed no outstanding differences.

All plats (exception 5 Kobe) were grazed. The Korean plats furnished the most, with Tennessee 76 next, but these are not significant. (C. D. Grinnells and R. L. Lovvorn)

**Lespedeza sericea as a supplementary pasture crop for cattle.**—During the season of 1937 the plant cover was allowed to mature. After maturing, the area having a dense plant cover was cut and the whole was evenly distributed over the barren spots, but this procedure has not given results equal to those obtained by other investigators. A few of the surviving plants on the bare areas were infected with a fungus disease that carried a crown rot of the stem.

Part of the cover from this plat was used in making a small amount of sericea-molasses silage. (C. D. Grinnells)

**Dairy cattle pasture Studies II.**—The data for this year show a greater yield for the plats receiving the heavier nitrogen applications, and marked increase in all plats with the exception of VI and VIII.

This is the third year in which Plat VII has received the  $P_2O_5$  treatment. Previous to that time it was used as a check plat.

## FERTILIZER APPLICATIONS PER ACRE

Plat No.	Pounds of Plant Food Per Acre		
	N	$P_2O_5$	$K_2O$
I.....	59.1	37.5	18.75
II.....	52.3	37.5	18.75
III.....	Check—No Fertilizer	Check—No Fertilizer	Check—No Fertilizer
IV.....		37.5	18.75
V.....	41.1	37.5	18.75
VI.....	29.95	37.5	18.75
VII.....		75.0	
VIII.....	18.75	37.5	18.75

## TOTAL DIGESTIBLE NUTRIENTS PER ACRE FOR EACH PLAT

	Plat I	Plat II	Plat III	Plat IV	Plat V	Plat VI	Plat VII	Plat VIII
10 year average.....	1953.9	2008.6	1387.6	1882.3	1862.4	1566.0	11,314	1365.6
1938.....	2358.0	2446.0	1894.0	2011.0	2080.0	1344.0	1216.0	1373.0
10 year alf. equiv.....	1.942	1.996	1.379	1.871	1.851	1.556	1.1124	1.357
1938 alf. equiv.....	2.343	2.431	1.882	1.998	2.067	1.335	1.208	1.364

(C. D. Grinnells)

**Dairy cattle Pasture Studies III.**—The data for 1938 show a small decrease in yield of nutrients which may be of little significance due to variation in productivity of cows and to unfavorable distribution of rainfall. Precipitation was the lightest during the two main grass growing months, April and August. These deficient periods came just after top dressing with nitrate of soda.

Plats IV and V have always given unsatisfactory results. These two plats have a rather shallow soil structure underlaid with a rock bed of such character as to make them immediately responsive to the effects of lack of rainfall.

Fertilizer applications per acre for the plats are as follows:

	Plat I	Plat II	Plat III	Plat IV	Plat V
Superphosphate.....	300 lbs.	300 lbs.	300 lbs.	None	300 lbs.
Nitrate of Soda.....	160 lbs.	260 lbs.	None	None	360 lbs.
Muriate of Potash.....	50 lbs.	100 lbs.	50 lbs.	None	50 lbs.

## TOTAL DIGESTIBLE NUTRIENTS PER ACRE

	Plat I	Plat II	Plat III	Plat IV	Plat V
Alfalfa Equivalent					
8 year average.....	2.135	2.156	1.410	1.283	1.921
1938.....	2.561	2.546	1.837	1.520	2.069

## TOTAL DIGESTIBLE NUTRIENTS

8 year average.....	2147.9	2169.6	1419.4	1290.9	1933.2
1938.....	2577.3	2562.0	1848.6	1530.0	2081.6

## Dairy Cattle Pasture Studies III-B

Yield Per Acre  
Net T.D.N.

Fertilizer applications and yield per acre

Plat I	246 lbs. 16 % $P_2O_5$	}	-----4380
	3000 lbs. lime		
Plat II	246 lbs. 16 % $P_2O_5$	}	-----3696
	100 lbs. Muriate of Potash		
	3000 lbs. lime		
Plat III	Check (no fertilizer, no lime)		-----2987
Plat IV	246 lbs. 16 % $P_2O_5$	}	-----4703
	100 lbs. Muriate of Potash		
	300 lbs. sodium nitrate		
	3000 lbs. lime		
Plat V	Check (no fertilizer)		3000 lbs. lime-----2975
Plat VI	246 lbs. 16 % $P_2O_5$		-----3972

This is a marked increase in yield over the previous year and it further confirms our tentative conclusion of last year that lime and phosphoric acid will go a long way in bringing back the pastures in this section. (C. D. Grinnells, R. E. Stitt)

**Roughage Studies.**—This is a study of comparative yields, protein content, digestibility and feeding value of hay cut on different dates in Ashe county.

Eight series with three replicate plats (5 feet square) were marked off to allow sampling at different stages for yields and chemical analysis at different stages of growth.

## YIELDS OF HAY AT DIFFERENT DATES, 1937

	Harvest Date	Hay Yield Pounds Per Acre*	Per Cent Protein	Protein Pounds Per Acre
Fertilized.....	June 15	2,480	7.29	180.79
	June 25	2,416	7.57	182.89
	July 5	2,532	8.75	221.55
	July 15	2,550	8.75	223.12
	July 25	3,241	8.66	280.67
	Aug. 5	2,567	8.63	221.53

\*The above is oven-dried hay. To change to an air-dry basis or field cure add 15 per cent.



The plant cover on this meadow was made up of red top, orchard grass, timothy and clover. There are about ten percent weeds over the entire area.

The above table gives the yield of protein per acre, showing a definite trend upward until about the first of August in a season of low rainfall. (C. D. Grinnells, R. E. Stitt)

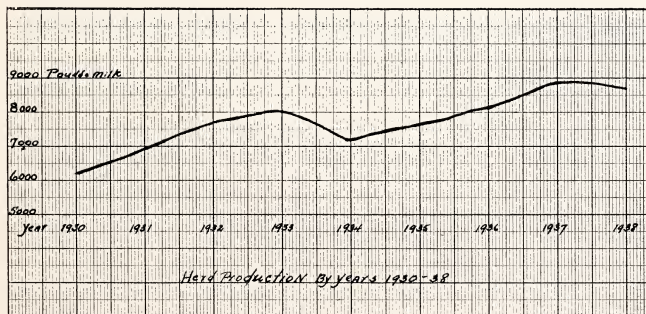
**Cooperative Dairy Crop Utilization.**—This is a study of a dairy enterprise coupled with a corn-cotton legume rotation.

From 1930 to 1938 the production has been almost doubled. This has been accomplished by the usual decline in net cost.

**TREND IN TOTAL MILK PRODUCTION; MILK PRODUCTION PER COW AND COST PER GALLON.**

Year	Total Milk Production Gallons	Milk Production Per Cow Gallons	Net Cost of Milk Production	Net Cost Per Gallon Cents
1930.....	4,052	506	\$ 1,141.09	28.16
1931.....	5,097	637	1,078.25	21.15
1932.....	6,945	868	921.13	11.37
1933.....	7,482	935	823.16	11.01
1934.....	6,656	832	968.17	14.55
1935.....	7,101	888	1,150.60	16.20
1936.....	7,570	946	1,114.67	14.72
1937.....	7,289	911	1,336.84	18.3
1938.....	8,120	1,015	1,195.71	14.72

The low cost of 1932, 1933, and 1934 is partly due to low feed prices during this period. (C. D. Grinnells, R. E. L. Greene)



**Studies of the whole peanut plant in dairy ration.**—This is the second part of a study to determine the value of the whole peanut plant in the dairy ration. In this comparative study the two following rations are compared:

Ration 1 (Regular)		Ration 2 (Peanut)	
Corn (ground).....	400 pounds	Whole peanut plant.....	1,000 pounds
Cottonseed meal.....	300 pounds	Cottonseed meal.....	500 pounds
Bran.....	200 pounds	Corn meal.....	500 pounds
Oats.....	100 pounds		

Ration 1 contains 17% protein and is 75.3% digestible.

Ration 2 contains 16.4% protein and is 71.6% digestible.

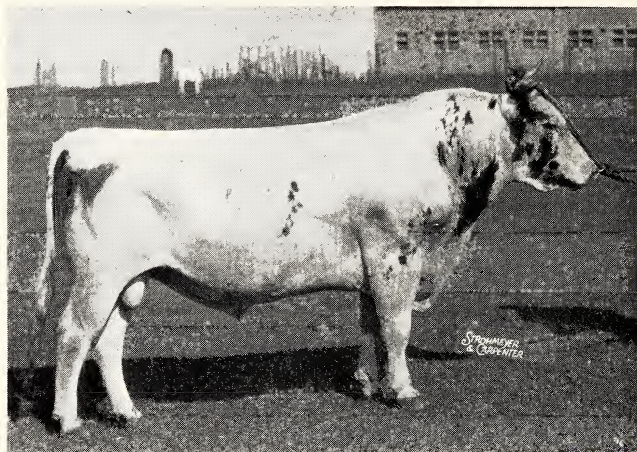


Fig. 7.—PUREBRED AYRSHIRE BULL—PENSHURST GERALD 38087.

Sire of eight daughters that have production records exceeding their dams by 1,768 pounds of milk and 101 pounds of fat. Gerald is the sire of a large number of daughters in the Sanatorium, Spice-Ayr, and Central Experiment Station herds that are now producing at a rate to exceed the above record.

The following data give part of the results:

AVERAGE MILK AND BUTTERFAT PRODUCED DAILY PER COW

Trial	Ration	Milk Pounds	Fat Percent	Fat Pounds
1937	Regular.....	24.60	4.33	1.073
	Whole Peanut Plant.....	25.61	4.46	1.142
1938	Regular.....	26.63	4.64	1.237
	Whole Peanut Plant.....	27.16	4.54	1.234

The data indicate that the whole peanut plant when ground will give satisfactory results as a part of the dairy ration. This fact will give

another outlet for the peanut crop when prices are unfavorable. (C. D. Grinnells)

**The economy of feeding beet pulp to cattle.**—In some sections of the state dairymen were supplementing their regular ration of mixed concentrates plus hay and corn silage with beet pulp. This was considered unnecessary when the supply of good corn silage was ample.

In the first feeding trial (Dec. 24, 1936, to March 7, 1937) there was no appreciable increase in production in the groups fed beet pulp. Less corn silage was consumed by these groups but beet pulp added materially to the cost of production. Gains in body weight were slightly larger in the beet pulp groups.

Beet pulp increased the cost of production of 100 pounds of milk 19.5 percent. (1936-37 trial.)

Beet pulp increased the cost of production of 100 pounds of milk 25.5 percent. (1937-38 trial.)

These data tend to show that

1. When an ample supply of good corn silage is available one is not justified in purchasing beet pulp when feeding for economical milk production.

2. Beet pulp at ordinary prices increased the cost of the ration and was not an economical substitute for good corn silage. (C. D. Grinnells)

**A study of digestion of *Lespedeza sericea* for goats and heifers.**—Digestion trials have been conducted on *Lespedeza sericea* with goats and heifers. The percentage of protein, fat, fiber, and nitrogen-free extract that is digested is of importance.

COEFFICIENTS OF DIGESTIBILITY OF A GOOD (EXTRA LEAFY) QUALITY OF  
LESPEDEZA SERICEA

Hay	Percentage Digestibility of Constituents				Total Digestible Nutrients Per 100 Pounds Hay
	Protein	Ether Extract Fat	Crude Fiber	Nitrogen-Free Extract Carbohydrates	
<i>Lespedeza sericea</i> (with goats).....	45	36	22	71	40
	39	39	23	70	39
Average with goats....	42	37.5	22.5	70.5	39.5
<i>Lespedeza sericea</i> (with heifers).....	29	42	16	81	28
	30	44	21	80	21
Average with heifers....	29.5	43	18.5	80.5	24.5

These coefficients were determined directly as in each *lespedeza* hay was fed alone for a period of ten days preceding the taking of data.

From the above data it appears that the goat cannot be used to study the coefficient of digestibility of *Lespedeza sericea* in place of the ox. The goats used in these trials ate the sericea hay readily and maintained their weight. The heifers did not eat sericea hay as readily, but they did lose weight. (C. D. Grinnells)

## SWINE STUDIES

1. **A study of methods of feeding Tokio soybeans to pigs (including grazing).**—From 50 pigs fed both individually and in groups, 40 graded hard, 7 medium hard, and 2 medium soft. One pig died en route. (Earl H. Hostetler, J. O. Halverson and Bureau of Animal Industry)

2. **Contents of vitamins A, B and G (ribo flavin) in principal varieties of soybeans and cowpeas grown in the state.**

The vitamin A and B content was determined for 12 samples representing 9 varieties of soybeans and one sample each of 4 varieties of cowpeas. The cowpeas contained no vitamin A and 80 percent as much B as the soybeans. Two varieties of soybeans contained vitamin A. The soybeans are rather high in vitamin B averaging 3.7 International Units per gram. (F. W. Sherwood and J. O. Halverson)

3. **Hardening peanut-fed pigs.**—Pigs of two weight classes of 35-45 lbs. and 60 pounds have been fed both individually and in groups supplemented shelled peanut rations to weights of 75 to 85 and 95 pounds, respectively, when hardening corn rations containing 13, 20 and 25 % cottonseed meal were fed to an average weight of 225 pounds. This procedure produced firm carcasses to the extent of 98.3 %. There was no advantage in feeding the higher percentages of cotton seed meal. (Earl H. Hostetler, J. O. Halverson, F. W. Sherwood and Bureau of Animal Industry)

4. **Menhaden Fish Oil as a source of vitamin D** was successfully fed at a rate of 1 percent in the growing mash of chicks up to eight weeks to a weight of two to three pounds. This oil gave equally as good growth as cod liver oil. (J. O. Halverson, F. H. Smith, F. W. Sherwood, and R. S. Dearstyne)

5. **The vitamin B ( $B_1$ ) content of meals from peanuts, cottonseed, soybean and linseed, and a critical evaluation of the rat-growth method of its determination** show that these meals are good sources of vitamin B. The values ranged from 1.1 International Units of vitamin B per gram for a sample of soybean meal to 5.4 International Units per gram in one sample of linseed meal. The other meals had intermediate values.

Raw shelled peanuts were found to contain 2.4 International Units per gram when previous data were interpreted by means of an estimating equation given in the paper.

It was also found that there is a seasonal variation in growth response to a given dose of vitamin B. This variation is most marked when the amount of vitamin B is only slightly greater than that required for maintenance. The rat apparently needs less vitamin B in the spring and early summer than in the late summer and autumn. (F. W. Sherwood and J. O. Halverson)

**6. Effects of feeding various amounts of soybeans in dry lot upon the growth and quality of meat in swine.**—The majority of carcasses of hogs which were fed the corn and cottonseed meal hardening ration following rather large amounts of soybeans, were firm. (Earl H. Hostetler, J. O. Halverson and Bureau of Animal Industry)

**7. The vitamin G content of some oil press-cake meals and related products.**—Peanut meal, linseed meal, cottonseed meal, soybean meal and soybeans were found to be good sources of vitamin G. (F. W. Sherwood and J. O. Halverson)

**A study of factors retarding growth of swine.**—Seven separate feeding trials have been completed on this project. A summary of the data show that:

1. During seasons favorable to the growth of pastures pigs weighing less than 100 pounds gained an average of  $\frac{1}{2}$  pound daily on pasture alone.

2. Pigs limited fed to 100 pounds weight, then full fed in dry lot to 225 pounds utilized their feed as efficiently as those full fed in dry lot during both periods, but required 63 days longer to attain the same weight.

3. Pigs, limited fed on pasture to 100 pounds weight, then full fed in dry lot, required 46 less pounds of concentrates per cwt. gain and 17 fewer days to reach 225 pounds average weight than pigs that were confined in dry lots during both periods.

4. Pigs that were full fed during at least one period yielded carcasses of higher market grade and greater firmness than those that were limited fed until slaughtered.

5. Pigs slaughtered at 225 pounds weight gave a higher dressing percentage regardless of method of feeding than those slaughtered at 100 pounds.

6. The roasted fresh pork, from pigs limited fed on pasture until ready for slaughter, contained less juice of a poorer quality than that from pigs fed by any of the other methods.

7. The desirability of aroma, flavor of fat and flavor of lean was less in the roasted fresh pork from pigs that had been limited fed on pasture until ready for slaughter than in that from the pigs that had been full fed during one of the two feeding periods or that had been limited fed in a dry lot during both periods. (Earl H. Hostetler and J. E. Foster)

**A study of rations in relation to production of soft pork.**—

1. The principal result of these experiments is the development of a practical method for the production of firm carcasses from peanut fed pigs. For the carcasses of 225 pound pigs to grade hard the peanut feeding should be started with animals weighing 60 pounds or less. The amount of shelled peanuts eaten should be limited to 90 to 100 pounds. The peanuts should then be discontinued and a hardening ration of corn with 13 to 15 percent cottonseed meal should be fed.

2. The degree of firmness, or grade, of a carcass may be estimated most accurately from either the iodine number of the back or the leaf fat, or from the melting point of the back fat. There is little choice between these fat constants and all three are more highly correlated with grade



than the refractive index of the back fat which has been used extensively for this purpose.

3. Adding cottonseed meal to the corn ration raises the melting point of the fat above that of fat from a carcass of corresponding grade from an animal not fed cottonseed meal. The effect on the other fat constants is not so marked.

4. There is a high correlation between the degree of firmness of the carcass and the amount of peanut, or other softening oil eaten by the pig. As little as 10 pounds of peanut oil may produce soft pork.

5. A softening (peanut) ration followed by a hardening ration yields harder carcasses than a single feeding period when the same total amounts of oil and starch are eaten.

6. Other factors being equal brewers' rice in the hardening ration produces firmer carcasses than corn. This is because brewers' rice contains very small amounts of fat, whereas the highly unsaturated oil in corn exerts an appreciable softening effect.

7. Although the weight at which the pigs are changed from the peanut to the hardening ration seems to be the most important single factor influencing the amount of hardening on the corn ration, it is not so much the change weight as the fact that the relative amount of peanut oil and corn starch eaten is largely governed by this factor.

8. In order to feed an appreciable amount of peanuts and produce firm carcasses, the peanuts must be fed to relatively small pigs. Usually the animals will eat the maximum allowable amount of oil by the time they attain a weight of 80 to 95 pounds. At this time they should be changed to the hardening ration.

9. Pigs weighing 100 pounds or more should not be fed peanuts if hard carcasses are desired.

10. A hardening ration consisting principally of corn with 12 to 25 percent cottonseed meal produces definitely harder carcasses than a supplemented corn ration without cottonseed meal. The optimum amount of cottonseed meal is between 13 and 18 percent. Nine and one-half percent is not enough, and 25 percent is no more effective than 13 percent.

11. The starch eaten in the hardening period should be about 6.6 times the amount of oil consumed in the softening period. This means that the pigs should eat almost 4 pounds of corn for each pound of shelled peanuts consumed. (Earl H. Hostetler, J. O. Halverson, and F. W. Sherwood)

**A study of different methods of feeding Tokio soybeans to pigs.**—Fifty 40 pound pigs were divided into six groups and were fed as follows:

- (a) 5 pigs individually fed 58.5% soybeans.
- (b) 5 pigs individually fed 78.5% soybeans.
- (c) 10 pigs group fed protein supplement plus corn to gain as Group d.
- (d) 10 pigs group fed hogging down Tokio soybeans plus protein supplement.
- (e) 10 pigs group fed protein supplement plus soybeans hand fed to gain as Group d.
- (f) 10 pigs group fed hogging down soybeans plus mineral self fed.



## RESULTS OBTAINED BY FEEDING SOYBEANS TO PIGS

Group No.	Days Fed			Average Daily Gain			Feed Per Cwt. Gain			Carcass <sup>†</sup> Grade
	1st	2nd	Total	1st	2nd	Total	1st	2nd	Total	
(a)-----	58	91	149	.79	1.54	1.24	294	396	371	H
(b)-----	66	87	153	.66	1.58	1.18	292	388	365	H
(c)-----	60	82	142	.73	1.67	1.27	271	389	360	H
(d)-----	56	86	142	.77	1.65	1.30	450*	392	406	H
(e)-----	63	87	150	.69	1.67	1.26	288	399	374	H
(f)-----	56	80	136	.83	1.79	1.39	759*	389	480	H

\*Yields of soybeans that were hogged down were evidently estimated incorrectly.

†(1) All carcasses hard from Groups c and f.

(2) All carcasses hard or medium hard from Groups d and e.

(3) All carcasses hard from Groups a and b, except one M.S. carcass in each of these two groups.

All of the above pigs were changed to a corn ration containing 13 % cottonseed meal at weights of 85 pounds, then carried on this ration until ready for slaughter at 225 pounds. The Group (d) pigs (soybeans hogged down) reached an average weight of 85 pounds after 56 days, making an average daily gain of .77 pound, while the Group (e) (soybeans hand fed in dry lot) required 63 days with an average daily gain of .69 pound. Four pigs in Group (a) (58.5 % soybeans) reached a weight of 85 pounds or more in 56 days, but all of the pigs except one in Group (b) (78.5 % soybeans) required more than 56 days to reach the required change weight of 85 pounds.

These light weight pigs have used soybeans to good advantage, have gained well, and remained thrifty and healthy. (Earl H. Hostetler and J. O. Halverson)

#### A comparative study of fish meal and peanut oil meal for fattening pigs.

—(a) In a comparison of peanut meal and fish meal as protein supplements to shelled corn for fattening pigs with initial weights of 73 pounds in which all feeds and minerals were self fed free choice, it was found that the pigs fed fish meal made an average daily gain of 1.79 pounds, and required 355 pounds of shelled corn, 31 pounds of fish meal and 2 pounds of mineral for each 100 pounds gain, while the pigs that received peanut meal made an average daily gain of 1.68 pounds, and consumed 274 pounds of shelled corn, 129 pounds of peanut meal, and 2 pounds of mineral for each 100 pounds gain. The group of pigs that were fed peanut meal, therefore, consumed more than four times as much protein supplement as those that were fed fish meal and required 17 pounds more feed per cwt. gain.

(b) In a second trial with 93 pound pigs, three parts of peanut meal were mixed with one part of ground soybean hay, and this mixture compared with fish meal. Again, the results were even more favorable for the fish meal group since they consumed only a total of 379 pounds of feed per 100 pounds gain, as compared to 434 pounds for the peanut meal-soybean hay group. The gains were not quite so rapid in either group as during the first trial, but the difference was greater since the fish meal

group gained 1.66 pounds per pig per day, and the peanut meal-soybean hay group 1.49 pounds. (Earl H. Hostetler and J. E. Foster)

## SHEEP STUDIES

**A study of the changes in meat and wool characteristics resulting from the use of purebred mutton rams on native ewes.—**

1. In this experiment throughout the periods at which weights were taken, namely, lambing, shearing, weaning, beginning and closing of the breeding season, and slaughter, the first cross Shropshire and first cross Hampshire ewes, both when yearlings and when mature, were materially heavier than the Native ewes. They were considerably lighter, however, than the purebred Hampshire ewes. The second crosses did not show an increase in weight over the first crosses, but they did show more improvement in conformation and quality. The Hampshire crosses as a whole, were heavier as yearlings and as mature ewes than the Shropshire crosses, but did not show as much quality.

The Native lambs were weaker and smaller at birth and gained less rapidly throughout the different periods than the lambs that were sired by Shropshire or Hampshire rams. The Hampshire crosses gained more rapidly than the Shropshire crosses, but did not equal the purebred Hampshire lambs in this respect. The single lambs of the same ancestry were larger at birth, and gained more rapidly during the nursing period than the twins.

2. The first cross Shropshires showed a substantial increase in percent of twins over the Natives, but this did not occur with the first cross Hampshires. The second cross ewes (both Shropshire and Hampshire) lambed approximately three weeks later than the other groups.

3. Fleeces from ewes sired by Shropshire or Hampshire rams were materially heavier and usually of longer staple than those from Native ewes. The Shropshire crosses showed more improvement in these respects than did the Hampshire crosses and their fleeces were also of higher quality, especially in fineness of fiber. The fleeces from the second crosses showed improvement over those from the first crosses only in quality of fleece.

4. The measurements of the live sheep and lambs brought out that the Shropshire crosses were much larger, deeper, and wider and had greater circumference of barrel, legs, and leg of mutton than the Natives, but were very little greater in height. The Hampshire crosses were longer and higher than the Shropshire crosses and had larger legs of mutton, but they were not deeper or wider. Neither were their circumferences of barrels and legs greater. There was not any noticeable difference in the measurements of the first and second crosses except in leg of mutton which was larger in the latter crosses. The purebred Hampshires were larger in every respect than the Natives or crosses.

5. There was no material difference in the dressing percentages of the various groups of lambs, but the Native carcasses, both lamb and mature ewe, were decidedly inferior to the others in finish, color of lean and fat and marbling. In these factors the Shropshire crosses were slightly superior to the Hampshire crosses. The fat over the rib eye, ribs, and

back was thicker in the second and third crosses and Hampshire carcasses than in the Native carcasses. The Shropshire crosses were thicker in this respect than the Hampshire crosses.

6. In proportion to their weight, the Native carcasses had greater length and were deeper through the chest than any of the other carcasses. The Hampshire crosses and purebred Hampshires were longer than the Shropshire crosses. The greatest improvements of the carcasses from the use of purebred rams were in size, proportionate weights of most valuable cuts, finish, color, marbling, and plumpness of leg.

7. Altogether a vast improvement in meat and wool characteristics resulted from the use of both Shropshire and Hampshire rams on Native ewes. Greater size and more rapid gains were obtained in the Hampshire crosses than in the Shropshire crosses, but the latter excelled the former in compactness and quality of form and in weight and quality of fleece. The second and subsequent crosses did not show as great an improvement over the preceding crosses as did the first cross over the Natives, but noticeable improvement continued, especially in conformation, quality, breed characteristics and quality of fleece until it was difficult to distinguish them from purebreds. However, the grades never equalled the purebred Hampshires either in size or in rate of gain, but they did in grade of market lambs. (J. E. Foster and Earl H. Hostetler)

## RURAL SOCIOLOGY

**A study of social activities and problems of North Carolina farm youth.**—All field work and tabulations have been completed on this project. Schedules were taken from 250 families in Toisnot township, Wilson county, in 1937. These data have been combined with those from the 1936 surveys of Guilford and Union counties. A manuscript entitled, "Farm Youth in North Carolina: A Study of Three Selected Areas," has been prepared incorporating the results of these surveys. The report includes an analysis of data from 750 rural households representing 2056 young people 15-29 years of age. Census data as well as information from previous studies have been used to supplement facts gathered in these surveys. Topics investigated include: occupational status, occupational plans and occupational anticipations, income and economic status, migration, education, educational plans, vocational training, social participations, family situations. The data are now ready for publication. (Robin M. Williams)

**A study to determine the economic and social effects on farms resulting from the operation of a definitely planned program of soil conservation.**—

**Economic Phase:** This project was started January 1, 1937, in cooperation with the Soil Conservation Service and the Bureau of Agricultural Economics and was continued throughout the current fiscal year. The purpose is to determine the effects of demonstration methods in soil conservation on farm organization, farm practices, crop and livestock production, and on farm income. Data were obtained through supervised farm account books and daily labor reports in the Cedar Creek Soil Conservation Demonstration Project Area in Franklin county. To date 75 account books have been closed for the year ending March 1, 1938. On

37 of these farms data were obtained on the hours of labor used on crops, livestock, and other farm work. Labor used and other data were obtained by fields on approximately 20 farms. Supplementary information on farm management and soil conservation practices are being collected by means of survey schedules. By the end of the current fiscal year approximately 75 farm management records and an equal number of soil conservation schedules will have been obtained.

A preliminary analysis has been made of the changes in cropping system from 1935 to 1937. Three groups of farms were used, SCS cooperators, AAA cooperators, and non-cooperators (or those not cooperating with either the SCS or AAA). The quantity of labor used on major crops have been summarized for SCS and non-SCS groups and for the combined groups. Data on labor by size of fields have also been summarized by operations requiring the use of power. The summary of weekly labor distribution by enterprises and for the entire farm will be completed by the end of the fiscal year. (S. W. Atkins)

**Sociological Phase:** The purpose of the sociological phase of this project is to determine the effects of a planned program of soil conservation on the life of farm families. Data have been collected showing the present condition of the farm dwelling, the household equipment, and farmstead. A study has been made of the migration into and out of the area since 1900 which shows where the migrants went and their occupational status before and after migration. Information on tenure status for three generations for these families now residing in the area, on the marriage relationship between various tenure classes since 1860, birth rate trends since 1880 by age, tenure, and race of mother; data on infant mortality, have been collected. A study has been made of the social conditions of the families and specific improvements which have been made. Maps showing landownership by ten-year intervals from 1720 to 1935 have been prepared. Tabulation of data is 90 percent completed. (M. Taylor Matthews)

## FARM MANAGEMENT STUDIES

**The organization and management of farms operated by cropper labor.**—This project has been in progress since 1928, when a farm survey was made of 112 farms located in Wayne, Pitt, Lenoir, Halifax and Edgecombe counties. In 1931 and 1935 re-surveys were made of many of the original farms. In addition to the farm survey records of the farms as a whole, individual records were obtained from 230 croppers living on these farms in 1928, and from 166 for those in 1934. Sixty-seven farm survey records were obtained from these farms on their 1937 business. All data obtained in the first surveys have been tabulated and some analysis made. As soon as the 1937 data are tabulated, an analysis of all material will be made. This study will reveal changes which have taken place in the organization and management of cropper farms under the Adjustment program. It will also throw some light on changes in the status of the croppers since 1928. (G. W. Forster and R. E. L. Greene)

**A study of organization, management and financial conditions of Farmers' Mutual Fire Insurance Companies in North Carolina.**—This is a continuing project, having been initiated in 1937. The field work thus

far has consisted in securing balance sheets and operating statements for the past ten years and a description of the operating methods and the business attitudes of the companies. This phase of the work is completed. A partial analysis of the information has been made, including loss and operating expense ratios, based on amount of insurance and on premiums received. Current data will be obtained from the annual reports of the Insurance Commissioner. A report will be prepared during the present fiscal year. (Marc C. Leager)

## CROP UTILIZATION STUDIES

**Utilization of crops by two different methods.**<sup>1</sup>—A three acre field that was of uniform topography, soil type and fertility was selected on the Upper Coastal Plain Test Farm in Edgecombe County in 1927, for determining the yields of cotton in a three year rotation with corn and soybeans when the feed crops were "hogged off". The field was divided into three equal plats of one acre each, and was handled as follows: Plat 1—Crops were harvested; Plat 2—Fertilized as Plat 1 and feed crops "hogged off"; Plat 3—Eighty percent of fertilizing value of feeds fed deducted from fertilizer application on succeeding crop and edible crops "hogged off".

**Rotation of crops.**—A three year rotation recommended for general farm practice in Edgecombe county was selected for use in this experiment and consisted of:

**First Year:** Corn (Latham's Double) interplanted with soybeans and fertilized with 400 pounds per acre of a 5-6-3<sup>2</sup> fertilizer mixture. The corn (grain) was harvested after maturity and the residue turned under.

**Second Year:**<sup>3</sup> Cotton (Mexican Big Boll) fertilized with 600 pounds per acre of an 5-8-3 fertilizer mixture.

**Third Year:**<sup>4</sup> Soybeans (Laredo) in rows for seed or hay and soil improvement, fertilized with 300 pounds per acre of an 1-8-4 mixture. The soybean seed were harvested and the residue plowed in.

The three different plats were planted to corn the first year (1927) and were all fertilized in the same manner. The three year rotation of corn, cotton and soybeans was continued until four crops of cotton were harvested.

It is felt that the yields of cotton as shown in Table 3 gives the most accurate picture of the results from the different methods of fertilization and harvesting of crops.

The value of "hogging off" the feed crops, in a practical three year rotation in which each crop is well fertilized, is evidenced by the average increased yield of 247 pounds of seed cotton from Plat 2 over Plat 1. On the other hand, the value of proper fertilization is shown in a comparison of Plats 1 and 3 in which the average yield of seed cotton was 45 pounds

<sup>1</sup> Credit is due Superintendent R. E. Currin, Jr., for his valuable suggestions and supervision of the project.

<sup>2</sup> Fertilizer analysis given in the order  $N-P_2O_5-K_2O$ .

<sup>3</sup> In 1928 and 1929 Abruzzi rye was seeded after cotton and soybeans, respectively.

<sup>4</sup> Season extremely dry.

TABLE 1—YIELDS OF CORN

Plat No. 1		Plat No. 2			Plat No. 3		
	Bushels	Estimated Bushels	Pork Pounds*	Supplement Fed Pounds	Estimated Bushels	Pork Pounds	Supplement Fed Pounds
1927.....	21.9	24.5	392	218	23.2	348	200
1930†.....	12.2	15.1	237	96	11.1	144	63
1933.....	24.7	38.9	649	119	27.9	465	104
1936.....	33.0	51.2	947	319	37.8	795	254
Average.....	23.0	32.4	556	188	25.0	438	155

TABLE 2—YIELDS OF SOYBEANS

Plat No. 1		Plat No. 2		Plat No. 3	
Year	Hay Pounds	Pork Pounds*	Supplement Fed Pounds	Pork Pounds	Supplement Fed Pounds
1929.....	2,560	500	1,604	455	1,599
1932.....	2,958	342	676	324	676
1935.....	4,800	464	904	480	898
Average.....	3,439	435	1,061	420	1,058

TABLE 3—YIELDS OF COTTON

Year	Plat No. 1	Plat No. 2	Plat No. 3
	Pounds†	Pounds†	Pounds†
1928.....	562	565	456
1931.....	1,271	1,612	1,262
1934.....	874	1,209	910
1937.....	1,307	1,618	1,208
Average.....	1,004	1,251	959

\*Pounds pork equals total gain of pigs.

†Season extremely dry.

†Pounds seed cotton.

greater when the proper amount of fertilizer was applied at time of planting. (Earl H. Hostetler and E. R. Collins)

## TAXATION STUDIES

A study of changes in taxes levied upon farm real estate in North Carolina during the period from 1913 to 1936.—The tax data collected from 1913 to 1936 have been analyzed and published as a mimeographed report



entitled, "Recent Changes in Tax Rates on Farm Real Estate in North Carolina." In this report the methods used in collecting and analyzing the data are presented in detail. There is a discussion of the need for and amount of ad valorem tax relief provided by North Carolina from 1929 to 1935. The changes in tax rates for the state as a whole, and for each of 52 counties are presented in tabular and chart form. The probable causes and the important effects of changes in tax rates on public services are discussed. Several remedial proposals are advanced and the benefits which might be derived from a more uniform flow of revenues are presented.

Under this project information is being collected on farm tax delinquencies. The study of delinquencies covers the period from 1928 to 1937, inclusive. Most of the information collected has been tabulated and partially analyzed. It is anticipated that a bulletin or mimeographed report will be prepared during the fiscal year ending June 30, 1939. (G. W. Forster)

## FINANCIAL STATEMENT

The following is a certified statement of the receipts from the Treasurer of the United States, supplementary funds from the State Department of Agriculture, and sales from the Station farms, with a record of their disbursements.

	Hatch	Adams	Purnell	Bankhead-Jones	Bankhead-Jones Offset
Dr.					
To Receipts from the Treasury of the United States, as per appropriations for fiscal year ended June 30, 1938.....	\$ 15,000.00	\$ 15,000.00	\$ 60,000.00	\$ 76,791.00	\$ 106,647.99
Cr.					
Personal Service.....	\$ 10,896.50	\$ 12,784.68	\$ 49,961.71	\$ 55,452.51	\$ 59,074.43
Supplies and materials.....	463.17	852.82	4,866.17	4,917.30	13,167.53
Communication service.....	215.69	.55	114.22	41.14	585.13
Travel expense.....	845.47	535.97	2,463.94	4,755.66	3,668.49
Transportation of things.....	20.34	31.91	101.72	341.36	158.24
Printing and illustrating publications.....	700.42		984.64	36.47	177.08
Heat, light, water, power.....		12.00	38.71	261.47	522.80
Contingent expense.....			1.24	5.01	103.95
Equipment.....	1,604.74	782.07	1,247.17	4,497.00	5,676.96
Buildings and Land.....	253.67		220.48	6,663.08	23,513.38
Total.....	\$ 15,000.00	\$ 15,000.00	\$ 60,000.00	\$ 76,791.00	\$ 106,647.99

Interest earned on above, during the period indicated, aggregating --NOTHING--, was covered by Check No. --NONE--, drawn by --xxxx--, to the order of the Department of Agriculture to be deposited in the United States Treasury.

We, the undersigned, auditors of the expenditures from Federal appropriations and Bankhead-Jones offset funds reported herein, do hereby certify that we have examined the books and accounts of the North Carolina Agricultural Experiment Station for the fiscal year ended June 30, 1938, that we have found the same well kept and classified as required, and that the balances, receipts, and disbursements are as follows:

	FEDERAL FUNDS					Bankhead-Jones Offset
	Hatch	Adams	Purnell	Bankhead-Jones	Total Federal Funds	
Balance from preceding year.....	None	None	None	None	None	None
Receipts from the Treasurer of the United States.....	\$ 15,000.00	\$ 15,000.00	\$ 60,000.00	\$ 76,971.00	\$ 166,971.00	
Receipts from sources within the State.....	None	None	None	None	None	\$ 106,647.99
Total.....	\$ 15,000.00	\$ 15,000.00	\$ 60,000.00	\$ 76,971.00	\$ 166,971.00	\$ 106,647.99
Disbursements.....	\$ 15,000.00	\$ 15,000.00	\$ 60,000.00	\$ 76,971.00	\$ 166,971.00	\$ 106,647.99
Balance June 30, 1938.....	None	None	None	None	None	None

Proper vouchers for the above disbursements are on file and have been examined by us and found correct.

WE FURTHER CERTIFY that the expenditures have been solely for the purposes set forth in the acts of Congress approved March 2, 1887, March 16, 1906, February 24, 1925, May 16, 1928, February 23, 1929, March 4, 1931, June 29, 1935, and June 20, 1936, and in accordance with the terms of said acts, respectively.

(Signed) I. O. SCHAUB,

Director of the Experiment Station

A. F. BOWEN, Treasurer

Financial Officer of the Institution

H. M. LONDON,

Secretary of the Governing Board

Auditors

Seal of Institution

ATTEST:

Custodian of the Seal

## NON-FEDERAL FUNDS

The North Carolina Agricultural Experiment Station  
In Account With  
Farm and Miscellaneous Receipts

	Balance from Previous Year	Receipts for 1938	Total
State Department of Agriculture, Main Station.....		\$ 26,350.00	\$ 26,350.00
Brushy Mountain Apple Research.....		5,000.00	5,000.00
Special endowment, industrial fellowship and similar grants.....	\$ 1,042.96	2,650.00	3,692.96
Sales.....	1,635.86	15,377.80	17,013.66
Miscellaneous.....	51.03	366.37	417.40
Total.....	\$ 2,729.85	\$ 49,744.17	\$ 52,474.02
Bankhead-Jones Offset Funds			
Branch Stations.....		62,798.32	62,798.32
Total Debits.....	\$ 2,729.85	\$ 112,542.49	\$ 115,272.34
Personal Service:			
Salaries.....		\$ 43,624.51	
Labor.....		17,751.02	\$ 61,375.53
Supplies and Materials:			
Stationery and Office.....		\$ 214.81	
Scientific consumable.....		275.85	
Feeding stuffs.....		9,634.38	
Fertilizers.....		1,599.36	
Sundry.....		1,668.77	\$ 13,393.17
Communications.....			\$ 722.49
Travel Expense.....			4,016.95
Transportation of things.....			171.39
Publications.....			862.96
Heat, Light, Water, Power.....			564.39
Contingent Expenses.....			4,614.11
Equipment:			
Furniture, furnishings and fixtures.....		\$ 600.55	
Library.....		12.50	
Scientific.....		435.26	
Tools, machinery, appliances.....		3,454.56	
Livestock.....		1,440.70	\$ 5,943.57
Buildings:			
New Buildings and Structures.....		\$ 2,005.52	
Non-structural improvements.....		31.15	
Repairs and alterations.....		1,172.93	
Rent of laboratory-office space, garage, etc.....		9.00	\$ 3,218.60
Land:			
Purchase.....		\$ 20,000.00	
Rent.....		389.18	\$ 20,389.18
Total Credits.....			\$ 115,272.34

NOTE: The above includes \$8,624.35 Not Used As Offset Funds.

\$115,272.34

8,624.35

\$106,647.99

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